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A Perseid meteor

Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor* HELEN S. FEDERER, *Managing Editor*

In Focus

THE famous California nebula, named for its striking resemblance to the outline of that state, is on the back cover. It is officially known as NGC 1499, and was photographed by Nicholas U. Mayall at the prime focus of the Crossley 36-inch reflector at Lick Observatory, Mt. Hamilton, Cal. The nebula lies close to Xi Persei, a 4th-magnitude star of spectral class *O7*; it is the exciting star for the nebulosity, causing the latter to give off an emission spectrum. In this reproduction, the much-overexposed image of Xi Persei is cut in half by the right edge of the engraving; west is at the top, and south is on the right.

This nebula was discovered by E. E. Barnard in 1885, with a 6-inch equatorial at Vanderbilt University Observatory, Nashville, Tenn. The discoverer said:

"It was a very difficult object with the 6-inch. . . . It lies on the edge of a region comparatively devoid of small stars. This is a very suggestive fact noticeable in the case of most of these large diffused nebulae, as shown in photographs of the large nebulous regions of Cygnus, Monoceros, Cepheus, Scorpio, and the present one in Perseus, where the nebulosity either lies in or on the edge of a vacancy among the stars."

Such irregularity in the distribution of stars along the Milky Way, which Barnard with his assiduous observing was then doing so much to establish, is now known to be the effect of obscuration by clouds of dark nebulosity often associated with bright nebulae such as this one. Thus Barnard's "vacancy among the stars" is explained.

In 1937, M. de Kerolyr, working at the Forcalquier station of the Paris Observatory, reported on his observations of the California nebula, made with an instrument of about 32 inches aperture:

"The nebula extends . . . over an area of more than two degrees. The width . . . is somewhat more than half a degree. This enormous mass of nebulosity has the appearance of filaments and is very difficult to see visually in the reflector. As a matter of fact, only the brightest portions can be seen."

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THE SHADOW OF THE MOON

By JOHN Q. STEWART, *Princeton University Observatory*

ANY QUICK, conscientious observer along the belt of totality July 9th, in Idaho, Montana, or southern Canada, can contribute observations of definite scientific interest, weather permitting, and can have an exciting experience as well. The explanation below makes even an amateur knowledge of astronomy unnecessary—although still desirable!

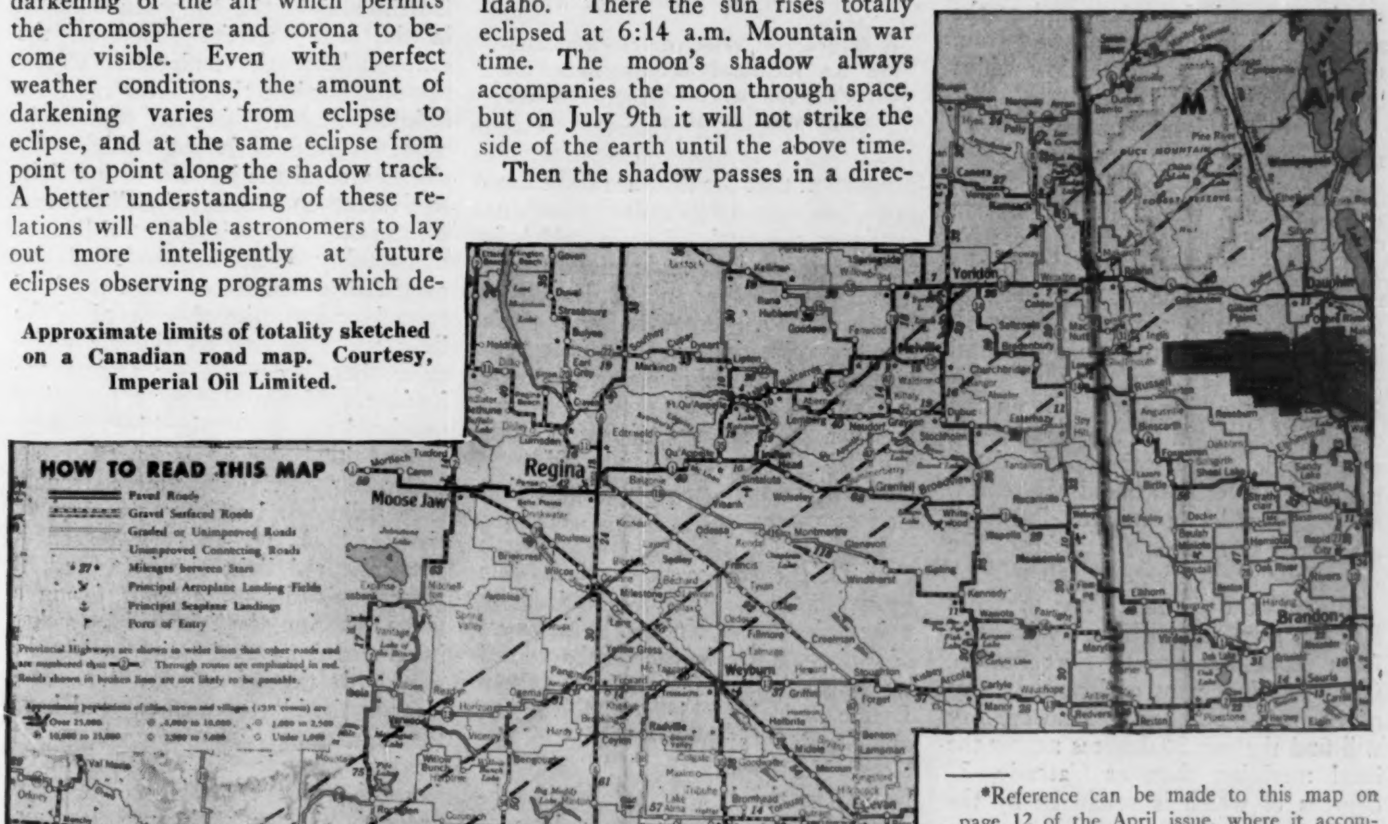
It is strange but true that notwithstanding all the laborious attention which professional astronomers have given to total solar eclipses, very few direct examinations have been made of the appearance of the moon's shadow as it passes through our air. Perhaps not strange after all, for the attention of astronomers has been so centered on careful instrumental studies of the sun's chromosphere and corona that they have had scarcely a glance to spare for the passage of the shadow. Yet it is the moon's shadow which makes the eclipse, causing the darkening of the air which permits the chromosphere and corona to become visible. Even with perfect weather conditions, the amount of darkening varies from eclipse to eclipse, and at the same eclipse from point to point along the shadow track. A better understanding of these relations will enable astronomers to lay out more intelligently at future eclipses observing programs which depend upon reduced illumination for their success.

The chance of bad weather is always discouraging to eclipse observers, but July weather prospects in Idaho and Montana are unusually good, as eclipses go. Records of the U. S. Weather Bureau show that the sun shines 75 per cent of the daytime hours in Montana in July, and still more continuously in Idaho. It will be advisable to avoid stations in river valleys or near ponds because of the possibility of the formation of fog during the relatively cool nights.

The following description of the position of the belt of totality should serve to attract the attention of potential observers who live not too far from it. As the *Ephemeris* map shows,* the central line of the shadow belt, where totality lasts longest (only half a minute in the United States), starts from an initial point about 10 miles southeasterly from Cascade, Idaho. There the sun rises totally eclipsed at 6:14 a.m. Mountain war time. The moon's shadow always accompanies the moon through space, but on July 9th it will not strike the side of the earth until the above time.

Then the shadow passes in a direction about 32 degrees north of east, the central line running about eight miles north of Salmon, Idaho; thence five miles south of Butte, Mont., two miles south of Saco in northeastern Montana, and one mile south of Opheim, which is eight miles below the Canadian border. It continues through a point one mile south of Ogema, Sask., thence halfway between Montmartre and Wolseley, and halfway between Bredenbury and Calder, all in Saskatchewan. It continues through a point about eight miles south of Camperville, Man., and after crossing almost uninhabited areas reaches the shore of Hudson Bay 114 miles east of York Factory.

Anyone can put this smooth line on his own large-scale map of a special district by following these approximate points. All the places mentioned, except York Factory, lie within the belt of totality, which is about



Approximate limits of totality sketched on a Canadian road map. Courtesy, Imperial Oil Limited.

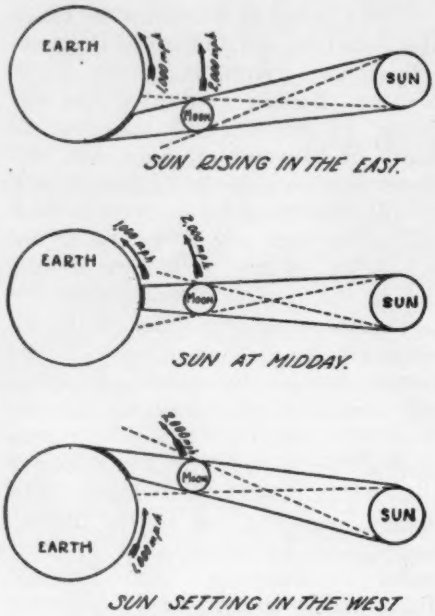
*Reference can be made to this map on page 12 of the April issue, where it accompanied the article by Isabel M. Lewis. It is from the official pamphlet, *Total Eclipse of the Sun, July 9, 1945*, containing maps and complete data on the partial and total phases, which is for sale by Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; 15 cents (do not send stamps) should accompany your order.—ED.

25 miles wide in the vicinity of Cascade and broadens to 33 miles at Opheim and 46 at Hudson Bay. These latter points will be nearer the moon than Cascade, and the moon's shadow cone will be larger for them. For an observer on a mountain peak or high in an airplane the shadow at his level is shifted. The belt of totality as outlined above is computed for sea level, and for any higher elevation must be shifted parallel to itself, by roughly one mile southeasterly for every 5,000 feet of elevation above sea level.

The duration of totality on the central line increases from 26 seconds near Butte to 31 seconds at Opheim, and to 37 seconds near Camperville and 48 seconds at Hudson Bay. This increase in duration is caused not only by the wider shadow, but also by the fact that the earth's eastward rotation begins in Canada to have an appreciable component parallel to the moon's motion. The observer is there held in the fleeting shadow for a longer interval. Where the shadow track crosses Greenland, these two effects combine to produce the maximum duration of 75 seconds. At the sunrise point in Idaho an observer is moving toward the moon, and at the sunset point in Turkestan away from the moon, so that the shadow whips by rapidly in either case.

The total eclipse requires only 12 minutes to pass from Cascade to Hudson Bay—a distance of 1,440 miles. It is, however, really the intersection of the moon's shadow with the earth's surface which moves so fast to the northeastward. The shadow cone in Idaho is actually moving downward, in the direction of the moon's orbital motion. The shadow of the moon formed by the rising sun falls on the earth's surface in Idaho at a very small angle, so that the speed of the moon in its orbit around the earth, about 40 miles a minute, is much magnified as regards the speed of the intersection with the earth's surface.

Where the central line reaches Hudson Bay—a spot roughly halfway from York Factory to Fort Severn, Ont.—is 27 degrees of longitude east of Cascade. Totality at Hudson Bay will find the sun 30 degrees nearer the local meridian than at Cascade, 27 degrees of which is produced by the easting, and one degree more for each four minutes later that the shadow arrives at Hudson Bay. In addition, the latitude of the Hudson Bay shore point, about 57° north, is more than 12 degrees north of the latitude of Cascade, and the sun on July 9th (even at the same longitude) rises some 65 minutes earlier at the more northern latitude. Since it takes the sun just two hours to move 30 degrees, totality at Hudson Bay will occur three hours and five minutes after sunrise. For points intermediate between Cascade and Hudson Bay, the interval after sunrise may be obtained, approximately, by interpolating between 0 and 3 hours in the proportion that the distance from Cascade bears to 1,440 miles. Compute similarly the sun's altitude, which is zero degrees at Cascade, nearly nine degrees at Opheim, and 22 degrees at Hudson Bay. Likewise, the sun's azimuth (direction from the observer) varies from 32 degrees north of east at Cascade, and 25 degrees at Opheim, to seven degrees north of east at Hudson Bay. West of longitude 105°, the sun will rise in partial eclipse, that is, for points west of Ogema, Sask.



A diagram of relative velocities during an idealized eclipse near the earth's equator, the case favorable to greatest duration of totality.

In the United States and southern Canada, the eclipse belt is accessible by numerous railways. Cascade is on a branch of the Union Pacific, west of Boise. Butte is excellently served by the main lines of both the Northern Pacific and the Chicago, Milwaukee, and St. Paul, and by a branch of the Great Northern as well. Townsend, Mont., in the belt of totality northeasterly from Butte, is on a loop of the Northern Pacific; and White Sulphur Springs, which is five miles on the shady side of the southern limit, is reached from the Milwaukee line. Niehart and Stanford, Mont., to name two more villages where totality will be seen, are on branches of the Great Northern, while Winifred is on a spur of the Milwaukee. Malta is a stop for all trains on the main line of the Great Northern; Opheim is at the end of a spur of the same railway.

Even in the sparsely settled West, many thousands of people live within very easy reach of the belt of totality, although it is true that many of the towns mentioned above have less than 1,000 inhabitants each. If this article leads to even one set of first-rate observations of phenomena connected with the passage of the moon's shadow through the air, a valuable contribution to science will have been made.

For it is a fact that this sunrise eclipse, in Idaho and Montana, affords an opportunity for non-instrumental observations of a type which, it seems, never yet have been made satisfactorily with a low sun. Detailed inspection of the passage of the moon's shadow through the air, and estimates of the general "twilight" illumination within the shadow are much to be desired. The moon's shadow completely cuts off the sun (that is, the brilliant photosphere), where it falls on the ground, but the earth's air outside the cone of shadow is still illuminated by weak sunlight in the heavy partial phases of the eclipse. The air molecules scatter this sunlight into the shadow and keep it from being anything like completely dark. A ring of bright twilight sky shines around the horizon with a light equivalent to scores of full moons. For an observer on the central line, at mid-totality, even the shadowed sky overhead is luminescent as a result of secondary scattering downward of the light which shines on the air molecules there from the air around the horizon. Hence the moon's shadow overhead appears dusky blue, if there are no clouds.

Air scatters blue light more strongly than yellow and much more strongly than red. For that very reason it transmits red light the best, and, if the moon's shadow extends far in a given direction, the light which reaches its center from sunlit air outside the shadow in that direction will be deficient in the blue component and have the red strongly favored. Where the shadow extends 50 miles or more from the observer this reddening is pronounced, even with pure clear air, and the horizon glow has a tawny hue. The bright light does not extend upward very far before it meets the shadow edge. But in a direction where the edge of the shadow lies only 20 miles or less away, this reddening (or yellowing) is not nearly so great, and if the edge is only five

miles or so away, the twilight glow around the horizon extends high into the sky and may be expected to be bluish white.

With James Stokley as a companion, the writer had the good fortune to observe these phenomena on June 8, 1937, from the center of the largest shadow of observed record. The observations were made in the Pacific Ocean from the freighter *Steelmaker* of the Isthmian Line, E. E. Lucas, master. This ship, winner of a little niche in scientific history, later became the victim of a German torpedo. These observations were described in a nontechnical way in the *Yale Review,* Vol. 29, Autumn of 1939, and the mathematical interpretation appeared in the *Astrophysical Journal,* Vol. 91, January, 1940.

That eclipse lasted 426 seconds. The moon's shadow on the sea was nearly circular, because the observations were made from a position near the noon point, at about 10° north, 134° west, where the sun was only 14 degrees from the zenith, and the shadow cone struck nearly vertically. The approximately circular shadow was nearly 180 miles in diameter where it intersected the surface of the sea; the shadow moved eastward at 25 miles per minute.

Because little attention had been paid before to the study of the general illumination in an eclipse shadow, the offhand expectation of astronomers, in which the writer shared, was that the remarkably large size of that 1937 shadow would result in an unusually dark eclipse. To our surprise, this expectation was not realized near the noon point, and it became no darker than in a summer afternoon's thunderstorm. The border of sunlit air outside the shadow, seen all around the horizon and extending at mid-totality to a height of perhaps 14 degrees, produced the illumination, as already described above. This year's eclipse gives a rare opportunity to extend to an accessible sunrise eclipse the analysis made in 1937 for a noonday one. The writer plans to observe it, probably in Montana, as a representative of the Princeton University Observatory, again with Mr. Stokley, who is now associated with the General Electric Company. But observations of this type by several parties at different places are desirable.

At an eclipse seen near sunrise or sunset there are two principal differences from conditions of illumination with a zenith sun. First, the moon's shadow cone, lying nearly horizontal, intersects the earth's surface near sunrise or sunset in an elongated ellipse, instead of in a circle as with a vertical shadow cone. The ellipse is elongated toward and away from the rising (or setting) sun. This means that the twilight band of illuminated air around the horizon at mid-totality lies at very different distances along and across the ellipse, with consequent emphatic variation in its appearance. In the two directions athwart the ellipse the glow will extend high above the horizon and exhibit little or no reddening because the shadow edge there is close at hand. But toward and away from the sun the shadow edge is relatively distant—and will be even farther in Idaho and Montana on July 9th than was the edge of the circular shadow from the *Steelmaker* in 1937. From moment to moment, the whole aspect of the sky will rapidly change as the shadow passes.

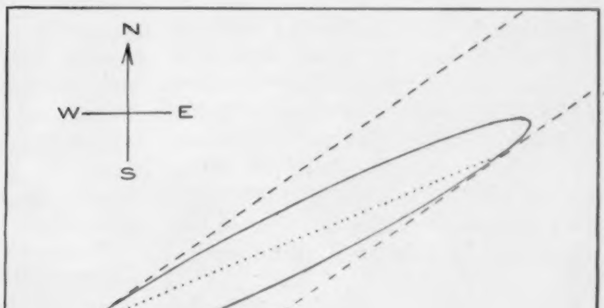
Several observers might well join together, each responsible for only one sector of the sky, to report on a phenomenon so various and which on July 9th will pass within so short a time. Photocells and other instrumental aid might usefully be employed, but intelligent visual observations can accomplish much. The horizon glow should be described, from moment to moment, with respect to direction, extent, brightness, and color.

The second difference of a sunrise from a noonday eclipse is that at exact sunrise the shadow is not moving horizontally eastward, but is *falling through the air.* Near the sunrise point the axis of the shadow is moving down from interplanetary space. The moon's shadow always accompanies the moon, but as it is completely dark we cannot see it until it strikes the upper air. Since the sunrise shadow cone touches the earth tangentially, its first effect is to produce a dim obscuration of the upper air all at once over a long belt extending nearly across the sky in the direction toward the sun. In the coming eclipse in Idaho and Montana, the long belt of the shadowed upper air will be noticed perhaps only 20 seconds before the eclipse becomes total at the ground. At the nearly zenith eclipse of 1937, on the other hand, the shadow first was descried as a small, dusky blot on the air to the westward, seen low on the horizon but really formed on air far above the sea and thus visible a long way off. This blot took two or three minutes to expand high enough to cover our zenith at the instant when totality commenced at sea level. Similarly, after totality ended the shadow was seen rolling away down to the eastern horizon.

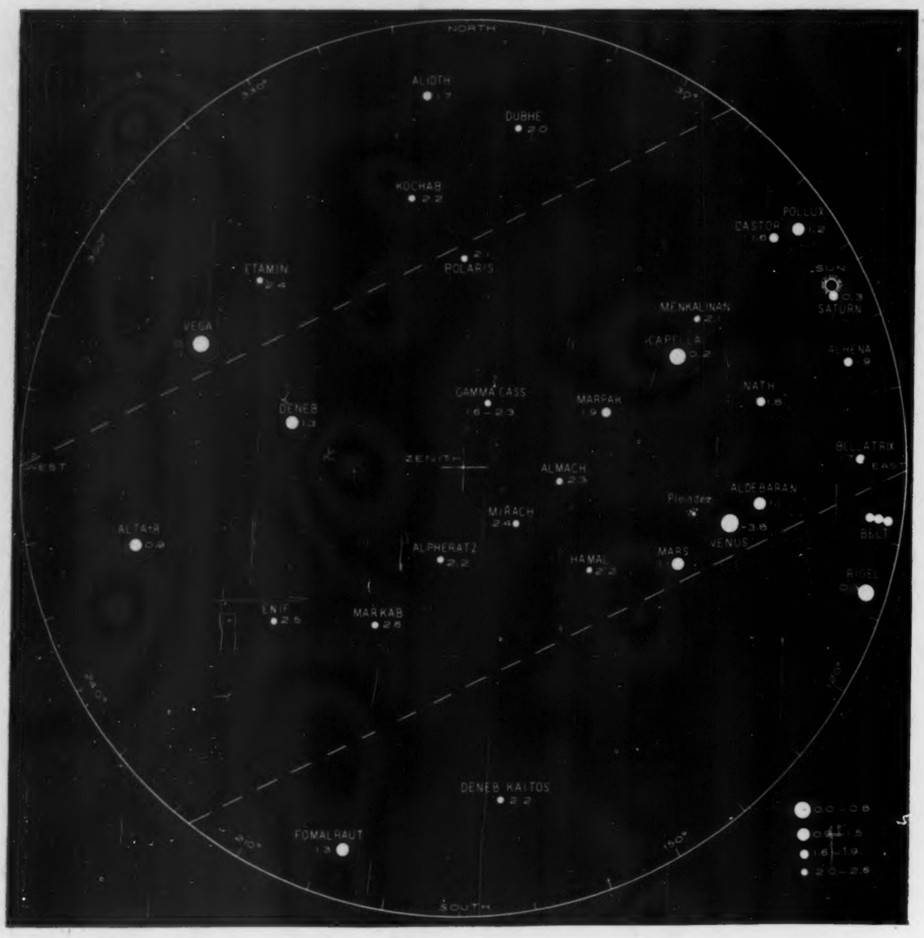
The shadow July 9th will not be moving straight down but at an angle with the horizon. Since 12 per cent of all the air lies above 50,000 feet, the darkening may become evident when the shadow edge still lies 10 miles above the ground, because the upper air then will have been affected. As more and more air becomes involved in the descending shadow, the dusky belt will darken and prolong itself rapidly eastward toward the sun. The instant it reaches the sun, totality commences. But as soon as totality ends and the first speck of glaring photosphere reappears, the shadow will have "gone to earth" and all the sky above the sun will be unobscured. Preliminary to this, there doubtless will be a gradual brightening of the shadow overhead for a number of seconds before the end of totality, because the eclipse will end first in the upper air. Then the shadow will rapidly shrink toward the sun.

So far as the writer is aware, no one has ever noticed in detail these phenomena of the "falling shadow," and Idaho and Montana offer many favorable sites for making the observations. Near the sunset point in Asia there will be a "rising shadow."

Sunrise or sunset eclipses are the darkest ones for a given size of the



The moon's shadow on the ground at 108° W., and its motion (between the parallel dashed lines) toward 055°. Totality is half over at points along the dotted line; such "equi-time" lines for each minute are drawn on the Almanac "Supplement" chart. The shadow cone is only 21 miles in diameter here—the minor axis of the surface ellipse—the edges are only 10 miles from a centrally located observer; the sky at no time will be very dark.



The brighter stars during totality on July 9th; computed for 108° W, 48° N, at 12:15 GCT, but the chart can be used for all points in Idaho, Montana, and Saskatchewan. The dotted lines show rough prospective limits of the moon's shadow in the sky at mid-totality. There will not be time in 30 seconds to identify most of the stars shown, even if they become visible. Venus should be very conspicuous, and Capella. Look for Altair in the west. Saturn, only 2 1/3 degrees from the sun, will be an excellent test. Stars fainter than these are not likely to be seen. Drawn by W. L. Hopkins, Jr., Princeton '47.

shadow cone, and with clear air what distinctness the corona loses by being seen through a long, horizontal air column is to some extent compensated for by the dimmer general brightness of the sky around it. In addition to reports on the appearance of the shadow in the air, it is highly desirable to have trustworthy estimates of how dark it gets at mid-totality for observers within a mile or two of the central line. One quick, rough way of estimation is to identify the faintest stars which can be seen. For this purpose, there is shown here a chart of the bright stars and planets above the horizon during totality. This must be carefully studied ahead of time, because totality is over so soon; predawn observations the morning of the eclipse should help such star identification considerably.

In the mountainous regions of Idaho and Montana, local knowledge is necessary for picking an observing site where there is an unobstructed outlook across lower mountains in all directions, and especially toward the rising sun. It would doubtless be necessary to camp the night before near the top of a favorable summit, with a glorious and unparalleled view of one of nature's grandest spectacles as prospective reward. In northeastern Montana the mountains have subsided to a rolling plain, still nearly half a mile above sea level, where many good sites are readily accessible to less athletic observers. In Canada the elevation is less, the expected weather not quite as good, and the elliptical shadow becomes much less elongated and therefore less interesting for the present purpose; but totality lasts longer, and the sun is higher. Observations of the shadow in Manitoba would be of value for comparison with others made in the United States.

Presumably the form of the corona will be well observed in Europe; in the very unlikely case of uniformly cloudy weather there, any photograph of the corona, on not too small a scale, will have some interest. It is just possible that from a high mountain a good photograph of the moon's shadow might be secured, on the ground or in the air; however, its outlines are vague.

The important things are: the description of the moon's shadow and of the horizon glow, and an estimate of the brightness of the general illumination at mid-totality, toward which identification of the faintest stars visible contributes. Star identification alone is a job to occupy the full attention of one person. Another might count seconds out loud so that relative times of observations before, during, and after totality can be recorded as closely as possible, within a very few seconds at worst; the exact time of totality is astronomically predicted and reliable within a second or two, so relative times may later be referred to it. The count should start when the visible remnant of photosphere has thinned to a short crescent, and the second of its vanishing, and again of its reappearing, should be noted. The inner corona becomes visible a few seconds before totality and remains visible afterward.

Get as close to the central line as you can; record your exact position. Observations by local amateurs east and west of the limit near Cascade are to be desired. Abnormal atmospheric refraction of the rising sun may result in displacement of the theoretical limit by a few miles toward or away from the sun. Southwesterly from Cascade 100 miles and more, in the Harney Basin region of Oregon, the moon's shadow will be briefly seen at 5:13 a.m. Pacific war time, immediately before sunrise, as a dark streak high in the air above the hidden sun, never reaching the ground there. Likewise, the descending shadow will be seen in the air to the southeast or northwest by observers not too far outside the long belt of totality, perhaps from 50 miles or farther to one side in Idaho and Montana. Observers are requested to communicate their findings to the present writer.

Warning: Advance rehearsals are a necessity! The eclipse will not recur. Inspect the proposed site of your station and use your imagination to suggest all possible preparations.

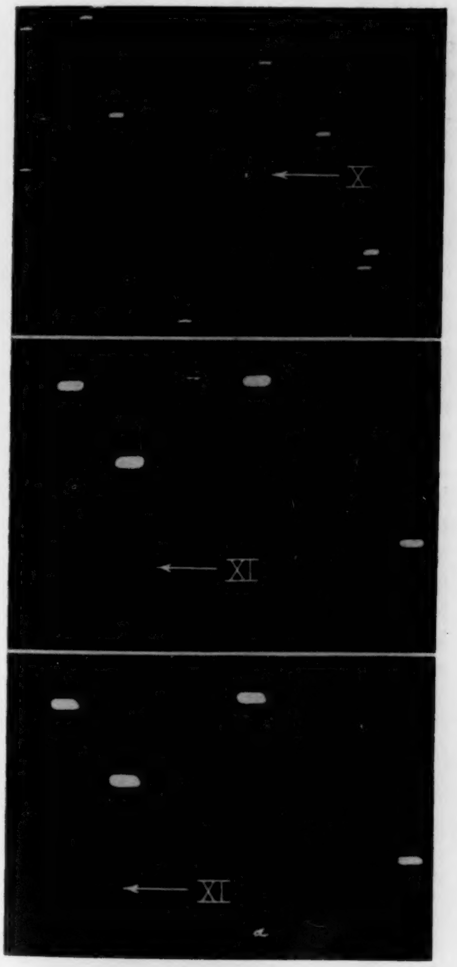
Record the weather conditions which prevail during the eclipse. State types of clouds, if identified. Note the color of the sky around the sun. State the distance at which hills and the like can be seen, as an indication of the purity of the air. Even if there is a high overcast the shadow may be apparent on the clouds.

Be continuously on the alert for unexpected phenomena, and write everything down *immediately* after totality.

The System of the Satellites of Jupiter

By Gustav Land, *Yale University Observatory*

THE SYSTEM of Jupiter consists of 11 satellites, so far as is known at present. The discovery of the four major satellites by Galileo, in 1610, was one of the earliest fruits of his newly constructed telescope. These four objects are of the 5th to 6th magnitude; they would be visible with the naked eye if the powerful glare of Jupiter did not outshine them. In contrast with this is the faintness of the other satellites. The fifth was found by Barnard with the 36-inch telescope at Lick Observatory in 1892, an object of about 13th magnitude; it is of particular interest because of its close proximity to Jupiter.



Jupiter X and XI, as photographed with the 100-inch telescope by Seth B. Nicholson. The top picture shows J X on August 25, 1938, exposure 31 minutes, length of star trails 10 seconds of arc. The lower pair is from the discovery plates of J XI, taken on July 30, 1938, exposure 60 minutes. The motion of J XI is shown by its change in position among the stars in the field. Mount Wilson photograph.

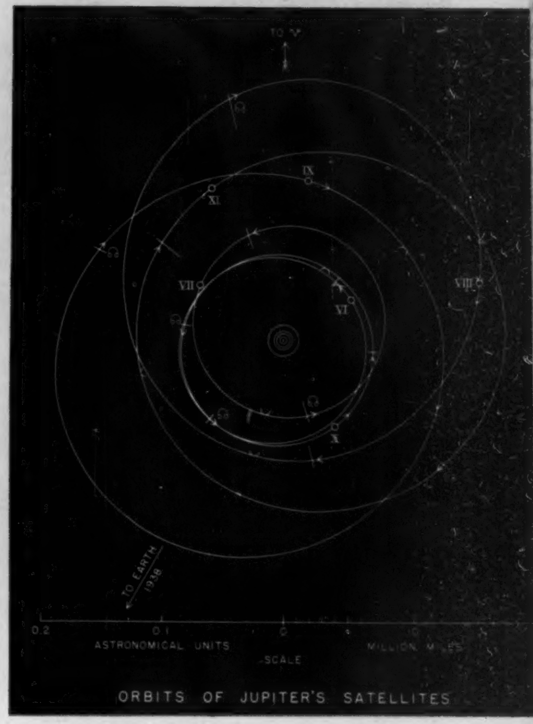
All of the succeeding discoveries were made photographically. The sixth and seventh satellites—also written as J VI and J VII—were found by Perrine with the Crossley reflector at Lick in 1904-5. Subsequently, J VI was identified on Harvard plates of 1894 and 1899; it is of 14th to 15th magnitude, approximately. In 1908, an eighth moon was discovered by Melotte at Greenwich Observatory; like J VII, it is of 17th to 18th magnitude.

Seth B. Nicholson succeeded in discovering three additional objects. In 1914, while at Lick, he detected on photographs of the eighth satellite a ninth. After this number could not be increased by photographs taken at all of Jupiter's oppositions for 20 years, a search was made in 1938 with the 100-inch reflector at Mount Wilson. By moving the telescope to follow Jupiter during the exposure, images of the very faint and distant satellites fall nearly at the same spot on the plate, while brighter stars produce elongated images due to the motion of the planet.

About 40 objects, moving approximately with Jupiter, were recorded. Among these were the known satellites and a number of asteroids, and in addition two new satellites which moved across the sky for a few days with almost the same speed as Jupiter. They are very faint objects, XI, like IX, of the 18th magnitude; X, about 19th magnitude. The situation is best described by the following remarks of Dr. Nicholson:

"They are so small and so far from the planet that an observer on Jupiter itself would require a 6-inch telescope to see them. Photographs of an hour's exposure with the 100-inch telescope are capable of showing much fainter objects than those that were found, and the fact that fainter satellites were not found indicates that if Jupiter has more undiscovered satellites, they are probably much fainter than those now known."

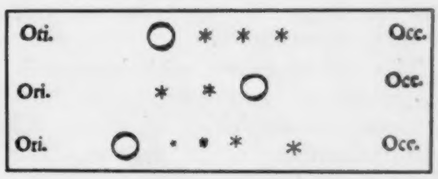
Kepler's third law provides a relation between the distances and periods for both planets and satellites. Although the distance of the first satellite from Jupiter is even a little more than that of moon-earth, its revolution takes only 1.8 days. This is due



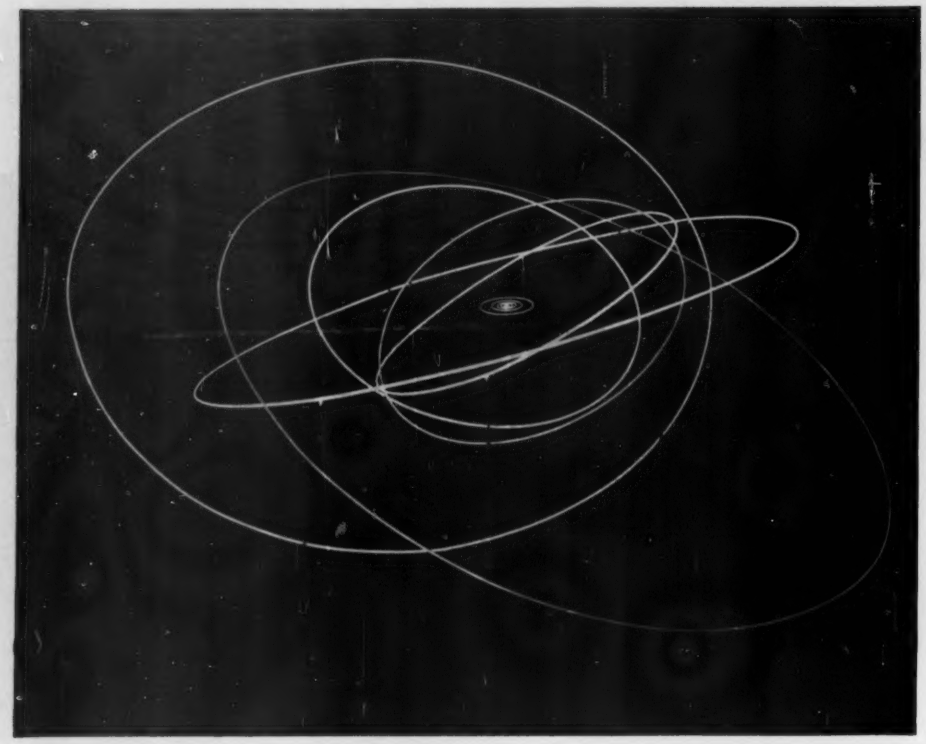
Each orbit is shown as in its own plane, and the positions of the satellites are for Jupiter's 1938 opposition. The small arcs of circles show each moon's perijove, or part of the orbit nearest Jupiter. The nodes on the ecliptic are marked, with the arrow showing the direction of motion on the part of the orbit north of the ecliptic plane. Diagram from Mount Wilson Observatory.

to the powerful attraction of Jupiter, which has 317 times the earth's mass. The period of a satellite of the giant planet must be multiplied by the square root of 317, or 17.8, in order to get its approximate period with respect to the earth.

Jupiter's satellites form three family groups which are separated very distinctly with regard to their distances and periods, the size and shape of their orbits, and other features. The first group consists of the four major or Galilean satellites, with most of



The first pictures ever made of Jupiter's satellites: drawn by Galileo on successive observing nights.



A model of the orbits of Jupiter's satellites. Note the small size and common plane of the five inner moons, contrasted with the high eccentricities and inclinations for the outer six satellites. Mount Wilson photograph.

the distances less than one million miles and periods between one and 17 days. It also contains the fifth satellite, which is very close to Jupiter at a distance 2.5 times the planet's radius; J V has a period of 12 hours. The second group contains satellites VI, VII, and X, at distances close to seven million miles and with periods of about 260 days. The third family contains VIII, IX, and XI, with distances of 15 million miles and periods of two years.

The orbits of the five inner moons are almost circular and are nearly in the plane of Jupiter's orbit. For this reason, the inner satellites come into eclipse by entering the shadow of the planet at every revolution, with the occasional exception of J IV only. The data for these eclipses, the occultations behind the disk of Jupiter, and the transits of the satellites' disks and shadows before the planet are given in the *American Ephemeris and Nautical Almanac*. These data have formerly been used for the determination of terrestrial longitude, but this is very approximate.

The second group, with intermediate distances and periods, exhibits moderate eccentricities of about 0.2 and inclinations of 28 degrees. The three outer satellites have larger eccentricities of 0.4, making the minor axes of their ellipses shorter than the major axes by eight per cent. Their inclinations are about 158 degrees; thus they move in the retrograde direction — very unusual for planets and satellites in the solar system. The mutual inclinations of their orbits are in part about as large as their inclinations to Jupiter's orbit.

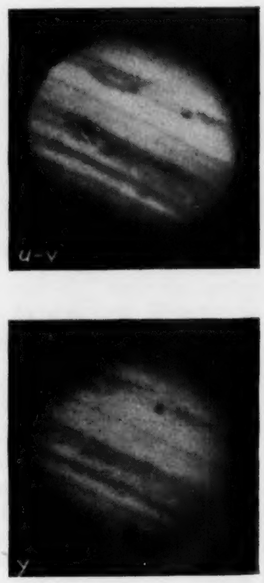
The early observation of the four Galilean satellites is closely connected with the discovery of the velocity of light. Since the periods of the satellites were known, the times of their eclipses could be calculated and predicted. When observing at these times, the Danish astronomer Ole Roemer found discrepancies up to several minutes varying within a year. When the earth was nearer Jupiter the eclipses came earlier, and when farther away they came later than the average. In 1675, he gave the explanation of the deviations as caused by the varying distance between the earth and Jupiter as the earth goes around in its orbit, and he found that light traverses the diameter of the earth's orbit in 22 minutes.

The establishment of a finite velocity for the propagation of light met the general disbelief of Roemer's contemporaries; much later the enormous significance of this thesis was acknowledged. In 1725, Bradley discovered the aberration of light, produced by the combined effects of the velocities of light and of the earth in its orbit. It was not until the last 100 years that the velocity of light was determined from terrestrial experiments (see *Sky and Telescope*, 29, 7, March, 1944). These modern results yield 16 minutes 38 seconds as the time for light to cross the earth's orbit.

Jovian satellites I and II are of the size of our moon, while III and IV exceed even Mercury. The diameters of the other objects can only be derived from their brightnesses and a reasonable assumption of their reflecting power. The faintest moon has a diameter of 15 miles, presumably; the brightest may be 90 miles across or larger.

The inner moons show considerable perturbations of their motions, and from these their masses can be determined. The mass of the brightest satellite, III, was found to be about double that of our moon. As a consequence of their perturbations, Laplace established a remarkable relation among the longitudes of I, II, and III, indicating that these three satellites can never be situated on the same side of Jupiter.

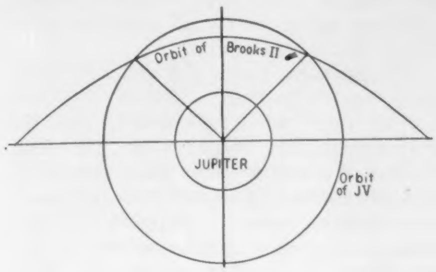
Three of the four bright moons have densities somewhat less than that of our moon; like the latter, they seem to consist of rock. Only the third satellite shows a very low density, namely 0.6 that of water. Its constitution may be similar to the outer layers of the surface of Jupiter; this would indicate a mixture of certain gases and water, mostly frozen. Markings on the surfaces of the four major satellites, particularly the third, are an additional feature in which they resemble the earth's moon. It has been established that J III always keeps the same face toward its primary.



Two photographs of Jupiter, the upper in ultraviolet light, the lower in yellow light. In each case, the shadow of a satellite appears as a small black dot on the planet. Lick Observatory photograph.

ANOTHER kind of perturbation applies especially to the nearest moon to Jupiter, V; it depends on the oblateness of Jupiter, whose polar axis is shorter by 1/16 than its equatorial axis. Under the influence of the oblateness, the orbital ellipse of that moon is rotating in its own plane around Jupiter, the major axis describing a whole revolution in 144 days. In addition to this, the orbital plane itself is rotating with about the same angular velocity but in the opposite sense, like a rotating peg-top with its oblique axis swinging around the vertical line.

The very small distance of this satellite from Jupiter is not the lower limit ever reached by a celestial body. Comet 1889 V (Brooks II), on July



Left: The orbit of Comet Brooks II around Jupiter.

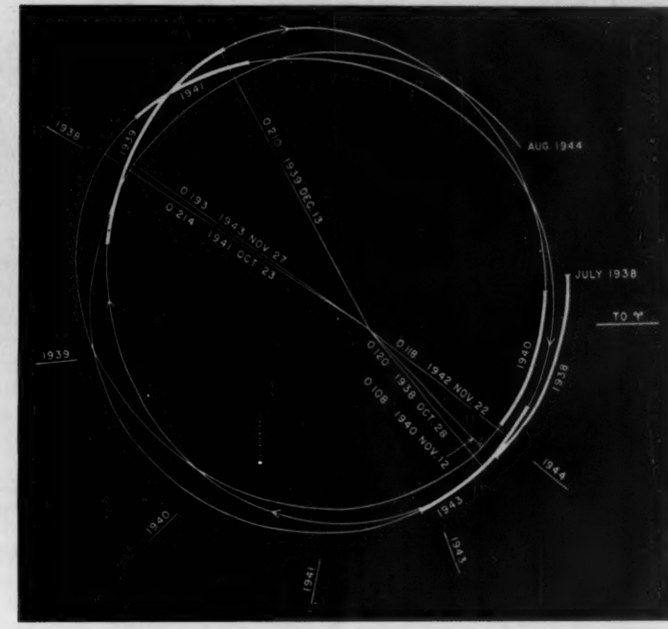
20, 1886, came within less than three quarters of the satellite's distance to the surface of Jupiter, or only 1.14 of the planet's radius. As seen from subsequent computations, the comet remained for two hours within the orbit of J V, describing an arc of 95 degrees in its hyperbolic orbit around the planet.

The perturbations of the comet due to the oblateness were then in part very considerable—almost double the effect on J V. Once, in 1779, Comet Lexell suffered great disturbances by Jupiter at the same place, increasing its perihelion distance so much it has remained invisible since then. The identity of these two comets has been suspected, but the question is not yet settled.

A FURTHER source of perturbations affects the motions of the outer satellites, especially of the third group which is exposed to enormous perturbations by the sun. A recent publication by Dr. Nicholson (*Astrophysical Journal, 100*, 57-62, 1944) on the orbit of J IX reveals the order in which changes of the orbital elements occur. Within the intervals of 1915 to 1918 and 1939 to 1944, the period ranged from 733 to 783 days, the eccentricity from 0.103 to 0.415, the inclination to the ecliptic from 152 degrees to 161 degrees. The orbital plane of IX was moving as was described above for the fifth satellite, but in the opposite sense. The line of nodes representing approximately the intersection between the orbital planes of the satellite and Jupiter performs one revolution within 81 years.

Thus the ordinary elliptical elements

The path of J IX projected on the orbital plane of September 28, 1940. The heavy lines indicate the part of the orbit in which the satellite was observed. The direction to the earth at each opposition is marked by the corresponding year. Diagram from Mount Wilson Observatory.



vary so rapidly that they describe this satellite's motion for a very short time only, and their significance in characterizing the orbit is lost. The latter is best defined by Jovicentric rectangular co-ordinates computed for equidistant intervals. The ranges in the elements for J IX are very similar to the preliminary ones for J VIII, which belongs to the same outer group.

These enormous perturbations raise the question of the stability of the orbits and the origin of the satellites, especially of the third group. It has been assumed that a slowly moving asteroid, under combined attractions by Jupiter and the sun, could have been captured by Jupiter, and that under extraordinary circumstances the satellite could move again out of the sphere of activity of Jupiter and become a faint asteroid. But according to Moulton, such a relation to asteroids seems improbable, the retrograde motion preventing the outer satellites from being lost to Jupiter's system.

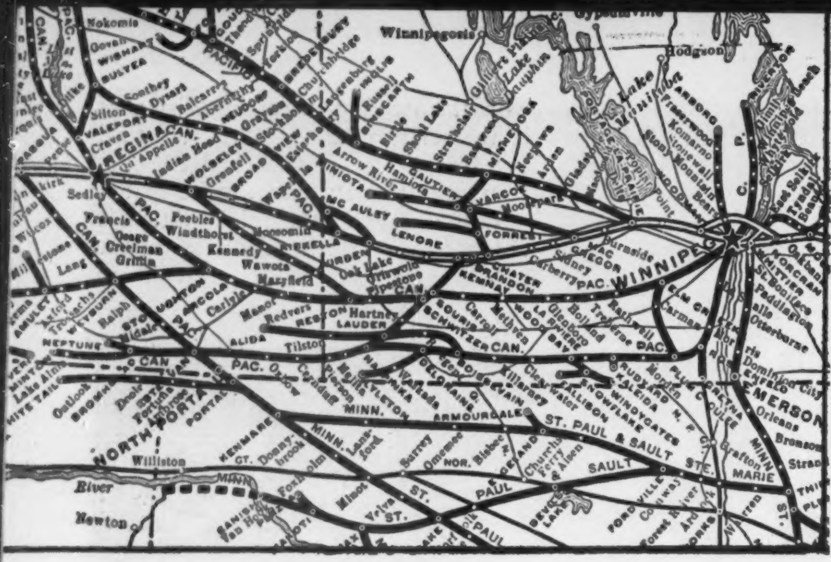
CAN the system of Jupiter's satellites be regarded as a smaller-scale image of the solar system? The first indications seem to contradict such a suggestion. As has been described, the three outer satellites have nearly the same distance to their planet, and so have the members of the intermediate group. This is in contrast with the steadily increasing distances in the solar system. Apart from this, however, a certain resemblance between the two systems can be found.

If the scale of the solar system is reduced to 1/220, the distances of the five inner objects in each system are similar, the fifth satellite corresponding to Mercury, J I to Venus, and so forth. For the belt of asteroids, an average distance of 2.65 astronomical units is here assumed. As to the sixth object, it looks strange, of course, that the place of Jupiter in the solar system is empty in the system of its satellites. But counterparts to the two outer groups of satellites may be seen in the solar distances of the planets Saturn-Uranus and Neptune-Pluto, for their respective means agree more or less with the distances of the two outer groups.

Therefore, the solar system reduced by the 1/220 scale factor represents roughly both the inner and outer dimensions of Jupiter's system. In consequence of Kepler's third law, this similarity extends also to the periods of planets and Jovian satellites, if the former are reduced by the factor 1/100.8.

Planets		*Distances in millions of miles* ÷ 220			*Jupiter's satellites*
Mercury		.16		.11	V
Venus		.30		.26	I
Earth		.42		.42	II
Mars		.65		.66	III
Asteroids		1.12		1.17	IV
Jupiter		2.20		—	—
Saturn		4.03		7.1	VI
	6.1		7.2	7.2	VII
Uranus		8.10		7.3	X
Neptune		12.7		14.6	VIII
	14.7		14.8	14.8	IX
Pluto		16.7		15:	XI

Eclipse Chatter



Courtesy of the Canadian Pacific Railway.

AN INVITATION

WESTERN Canadians will be very glad to welcome any visiting amateurs and astronomers to the eclipse region in July. Our weather then is usually fair and warm with some thundershowers. The eclipse region in Saskatchewan and western Manitoba is crisscrossed by roads and railroads, although most main roads are graveled and some of the rail lines have infrequent service.

Taking places marked on various published maps within or near the path of totality, Ogema is very small, unhandy; Weyburn, Yellow Grass, Lang, and Milestone are all on the Soo line branch, good train service from St. Paul. Weyburn is a little city, the others are small towns, Lang the smallest. Odessa and Montmartre are little places on a main line branch of the Canadian National, handy to reach from Regina. Wolseley and Grenfell are on the main line of the Canadian Pacific, with good train service, both small towns. Bredenbury has daily local service, and Yorkton is on the same branch—it is a small city. Roblin is a village with a small hotel.

The prairie south of Regina is treeless and level, but northeast of there it is rolling with some bluffs of trees. There is good visibility in every direction almost everywhere, but with the eclipse happening so soon after sunrise, one should find a hill or a roof to look from. Riding Mountain Park has plenty of thick bush, with trails and roads cut through, but good clearances around the lakes. This park is unhandy without a car.

As a sample itinerary for United States' visitors in a hurry, one can leave St. Paul on the Great Northern Saturday evening, July 7th, reach Winnipeg the next morning, get a direct connection for Melville and reach there about 6:00 p.m. There would be time to find an observing site, set up equipment, and get a good night's rest before the early morning call. Melville has two transcontinental and a local passenger train each way every day, and boasts a couple of railroad men's hotels—sufficient accommodation except for large crowds. After the eclipse is over, one can leave Melville at noon and reach St. Paul Tuesday morning early enough to make connections with all trains.

No passports are needed, though it is a good idea to carry identification papers. All banks and most hotels will give you 10 per cent premium on American money. Visitors' ration books are easily gotten for butter and sugar.

For our part, we shall try to have the weather man on his good behavior for the event.

JESSE KETCHUM
Saskatoon, Sask.

SOME VANTAGE POINTS

CANADIAN NATIONAL RAILWAY SYSTEM, in answer to several inquiries, has made a survey of some points on their lines, and the following is taken from their letter to the editor.

Roblin has a population of 750, and is 240 miles from Winnipeg. Nine miles directly west from this town is the Assiniboine River valley, and on the western side of the valley, on Highway 10, in Saskatchewan, there is an elevation of approximately 400 feet from the riverbed. At the highest point there is considerable open and level terrain, and it appears to give a very good view toward the eastern horizon.

Pine River has a population of 250. From the village three fourths of a mile to Highway 5 (on a ridge) northeast, there is an elevation of about 40 feet, and for at least a mile and a quarter north on the highway above and facing Pine River there is a stretch of high, open land, with a good eastward view.

The headquarters office of Canadian National Railway System offers further information on train service and hotel and boarding house accommodations at these and other points. Address W. S. Thompson, director of public relations, C. N. R., Montreal, Quebec, Canada.

WEATHER—THE UNPREDICTABLE

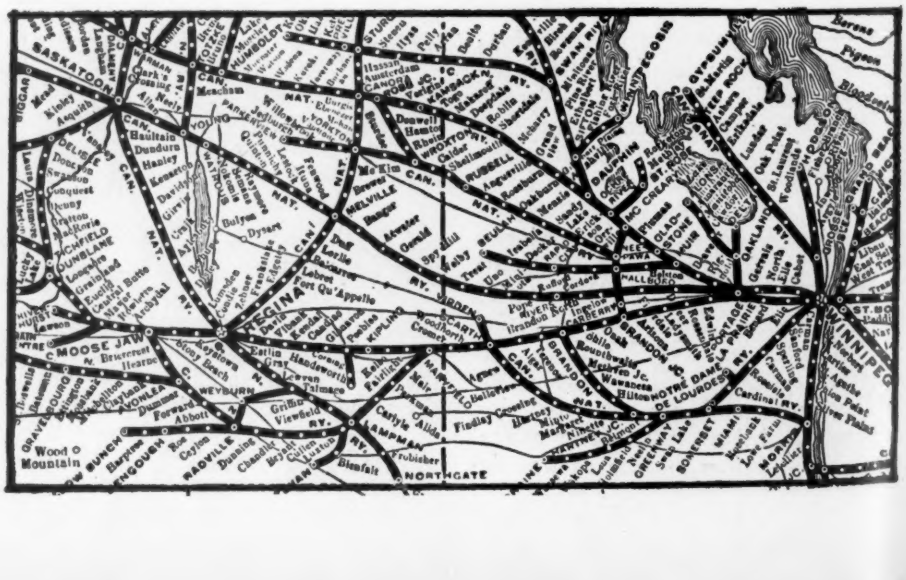
WEATHER conditions for the entire region of the eclipse in Canada have been reported by A. J. Connor, of the Meteorological Service of Canada, in the February number of the **Journal** of the Royal Astronomical Society of Canada. The Meteorological Service is "anxious to give all possible assistance to anyone who is planning" to observe the eclipse, but Mr. Connor's article seems to cover nearly all possible questions. Significant points are:

"It appears from the records that from Regina to Hudson Strait the number of days with measurable rain in July everywhere averages 10 . . . . The chance of a day without rain, therefore, is approximately 2 out of 3 . . . . Cloudiness observations . . . support the idea that the chance of good weather for observation is smaller along the west coast of Hudson Bay than on the prairies."

A table shows that at Regina at the hour of totality, the cloud cover is from 0 to 2/10 about 40 per cent of the time; from 3/10 to 7/10, 19 per cent; from 8/10 to 10/10 about 42 per cent of the time. Thus the chances of very clear or very cloudy sky are about equally probable. At Yorkton the respective percentages are 44, 24, and 32, which is slightly more favorable.

"On the whole, it appears that the best chance of viewing totality on July 9, 1945 lies in the Saskatchewan area. We believe that reasonable chances of success are about the order of 3 in 5 in Saskatchewan and probably less than 3 in 10 in the Hudson Strait area, with the region around God's Lake intermediate."

***Courtesy** of the Canadian National Railway.*



Amateur Astronomers

A.A.A. OF PITTSBURGH HAS SUCCESSFUL SEASON

WITH THE meeting on June 8th, the 1944-45 season of the Amateur Astronomers Association of Pittsburgh will be concluded, marking the end of another successful year in the history of the society. Attendance at the monthly meetings has been well sustained and enthusiasm has not lagged. The lectures have been both interesting and informative. Thirty six new members have been enrolled during the past year.

In addition to our regular lecture meetings, the society this year sponsored, jointly with the Buhl Planetarium, a series of six lectures on "Telescope Construction and Use." These were given free to all interested persons. Twenty one of our members, functioning as the telescope committee with Dr. Emil J. Burcik as chairman, continue to serve at the siderostat telescope atop the planetarium, lecturing on the various celestial objects as they come into view. During the past year, approximately 4,500 visitors have been entertained by this committee.

Leo N. Schoenig, besides serving as president this year, continued as supervisor of our workshop maintained in the planetarium building. Despite the exigencies of war time, much has been accomplished: six 6-inch reflecting telescopes have been completed; ten 6-inch mirrors completed; fifteen 6-inch mirrors in process; two 8-inch mirrors completed; one 8-inch mirror in process. Among the miscellaneous items produced is a 2x2-inch slide projector, intended for use by the members in illustrating lectures. Several parts were also machined for a ruling engine which is being constructed by William Soukup.

The A.A.A. of Pittsburgh established a library this year. The books, old and new, dealing with astronomy and related sciences, were donated by several of our members. Miss Margaret Scheboth is the faithful and efficient librarian.

The chairmen of the standing committees deserve recognition for the diligent performance of their duties. The program committee, Roelof Weertman, chairman, procured excellent speakers; Clarence A. Atwell was chairman of the educational committee; H. M. Priest, planetary committee, has faithfully prepared monthly astronomical notes. C. W. Fisher has been treasurer for the past three years; he is an expert accountant, and his care of our finances is a model of perfection.

The executive committee of the Pittsburgh amateur society: (front row, left to right) Louis E. Bier, Leo J. Scanlon, Roelof Weertman, (back row) H. M. Priest, Leo N. Schoenig, Willard A. MacCalla, Clarence A. Atwell.

Election of officers and an astronomical quiz with J. Hawk as quizmaster are on the program of our meeting in May. We look forward in happy anticipation to another year as enjoyable as the one now closing.

LOUIS E. BIER, secretary
A.A.A. of Pittsburgh

SPECIAL ACTIVITIES

Cincinnati: The annual Star-Gaze of the Cincinnati Astronomical Society is scheduled for Saturday, May 19th. Telescopes will be available, and the public is invited. The group will meet at the end of the Fairview car line at 8 o'clock.

New York: The annual meeting of the Amateur Astronomers Association will take place on Wednesday, May 16th, at 8:00 p.m., in the Roosevelt Memorial building of the American Museum of Natural History. At the business meeting there will be elections, and reports of officers and committees, to be followed by a special motion-picture program.

ECLIPSE PLANS

In the June issue we shall publish plans (now mostly tentative) of several professional astronomers and of a number of amateur groups arranging to observe the total eclipse on July 9th. Meanwhile we invite further correspondence from individuals or groups, and will supply available information concerning specific expeditions, upon request.—ED.

THIS MONTH'S LECTURES

Chicago: Wagner Schlesinger, newly appointed director of the Adler Planetarium, will speak to the Burnham Astronomical Society on "Receding Horizons—Man's Expanding Conception of the Universe," at its May meeting. There will also be at this meeting a general discussion of the May evening sky. The date is Tuesday, May 8th, at the Chicago Academy of Sciences auditorium, 8:00 p.m.

Cleveland: David Dietz, science editor of the Scripps-Howard newspapers, will speak to the Cleveland Astronomical Society on May 4th, Friday, at 8:00 p.m. His topic will be "Science of Tomorrow." The meeting is at the Warner and Swasey Observatory.

Detroit: At the meeting of the Detroit Astronomical Society on Sunday, May 13th, Professor Russell C. Hussey, of the geology department at the University of Michigan, will talk on "Old Volcanoes and Old Mines of North America." The lecture will be illustrated with original films belonging to the University of Michigan.

Indianapolis: At the meeting of the Indiana Astronomical Society on May 6th, Sunday, members will hear a talk by Howard Miner on "Jupiter." The group meets at Odeon Hall at 2:15 p.m.

Madison: H. B. Porterfield will speak to the Madison Astronomical Society on "Solar Eclipses and the 1945 Eclipse," at the meeting of this group on May 9th, Wednesday, at the Washburn Observatory.

Philadelphia: "The Cosmic Time Scale" is the title of a lecture before the Rittenhouse Astronomical Society, on Friday, May 11th, at 8:00 p.m. in the Morgan Physics Laboratory of the University of Pennsylvania. Dr. Bart J. Bok, of Harvard College Observatory, is the speaker.

Washington: "The Discovery of the Satellites of Mars" will be the subject of the lecture before the National Capital Amateur Astronomers Association, by the president of the society, Dr. Edgar W. Woolard. The meeting is on Saturday, May 5th, 8:00 p.m. at the National Museum. Election of officers will take place at the business meeting.

WHY TH

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Here and in the Hayden Planet
explain its causes and partly to
which

On spring evenings in mid-northern latitudes, the new crescent moon always appears nearly horizontal. Photo by R. G. Stephens.

ALTHOUGH man has learned to control many of the natural factors which combine to make up his daily life, the weather still remains somewhat beyond his directing influence. Like it or not, he must take hot, sunny days, cloudbursts of rain or snow blotting out the clarity of his earth-scene, and the general meteorological potpourri of hurricanes, soft breezes, tornadoes, and dead calms. During the years, it is true, man has learned much of the art of protecting himself from the weather, not only by adapting his clothing, shelter, and food to changing and extreme weather conditions, but also by forecasting weather of the immediate future.

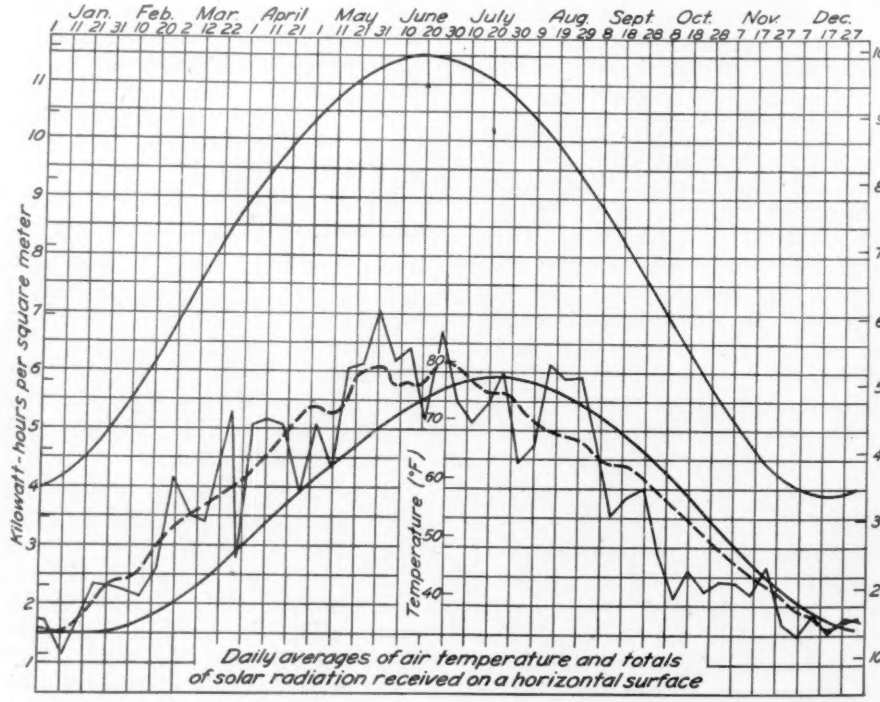
It is perhaps in this field of weather knowledge that the most amazing and rapid advances are being made. Many of the details of the new science of long-range weather forecasting must remain secret until the end of the war, but there is little doubt that much of our success in military operations has depended on the ability of meteorologists to foretell periods of clear and rainy weather some time in advance.

Quite recently, Dr. Charles G. Abbot, retired secretary of the Smithsonian Institution, announced that in the future it will be possible to foretell in January the kind of weather which will be available for a June wedding. He believes that in the postwar world there will be no necessity for uncertainty as to the weather of the future. His theory is, of course, that the weather on the earth is largely controlled by the variations occurring from day to day in the sun's heat.

All weather upon the earth is caused by two prime factors, the sun and the envelope of air which surrounds the earth, which we call the atmosphere. The atmosphere is a combination of gases, of which the most important to human beings is oxygen, without which life would be impossible. Within this layer of gases, extending some 500 miles out into space from the surface of the earth, occur all those manifestations which we label collectively "weather." It is the heating, the cooling, the restless motion of the atmosphere which give us our different kinds of weather. And this heating and cooling and motion are dependent in the last analysis upon the variations in the heat which we receive from the sun. It is rather astonishing to realize that all our weather, cyclonic and frigid as well as calm and warm, rainy as well as sunny, is made 93 million miles away, on the sun.

We think of weather as so intimately and personally connected with our own planet and our own lives that we obtain a somewhat new perspective when we realize that other planets, far removed from us, have also their own peculiar types of weather. Strictly speaking, where there is no atmosphere, there can be no weather in our sense of the word. That would rule out both Mercury and our moon. On these airless bodies there are tremendous variations of temperature, but none of the manifestations of weather such as rain, clouds, or winds.

We can say little about weather on Venus, since the heavy cloud layer which surrounds the planet is impenetrable to our sight. According to the



A chart of the varying amount of sunlight during the year. The lag of the seasons is shown by the solid curve in the lower graph.

HE WEATHER?

ARIAN LOCKWOOD

n this month we talk about the weather, partly to you avoid accepting weather hints and proverbs thout scientific foundation.

Most mid-afternoon storms pass off to the east, which is the direction then to look for the rainbow. Photo by Charles H. Coles.

measurements of Pettit and Nicholson, the dark side of Venus shows a temperature of about —9° F., and the hot side is in the neighborhood of 130° F. In the clouds of Venus, there has been no evidence discovered of either free oxygen or water vapor.

Mars goes through regular seasonal cycles much like those of the earth—the Martian year lasting 687 earth days. The red planet receives about 40 per cent as intense heat from the sun as we do, but even so the noon temperature sometimes reaches 86° F. The midnight temperatures must usually be well below zero. No water vapor has been identified in the Martian atmosphere, but there is some evidence of mist and snow.

As for the giant planets—Jupiter, Saturn, Uranus, and Neptune—they are all very cold, with heavy atmospheres made up largely of ammonia and methane. There is evidence of much restlessness within and below the cloud layers, pointing to tempestuous conditions above the surfaces of these planets.

As for weather and weather signs on the earth, there has been from earliest time a tendency in man's mind to make a quite understandable though erroneous connection between the manifestations of weather and the appearance of the heavenly bodies. We know today that there is only one celestial body which affects our weather—and that is the sun. There are, however, many millions of people who continue to believe in the weather potency of certain stars, the moon, and various celestial phenomena.

One of the most common weather superstitions, and it can be called by no other name, is that of the "wet moon" and the "dry moon." According to one school of the so-called weatherwise, you may be sure that rain is imminent when you see the young crescent moon standing almost vertical in the western evening sky; they say this is the wet moon because the water would spill out on the earth below. The other school of thought maintains that the vertically placed crescent moon is the dry moon, because obviously all the water has already fallen out of it, and the crescent parallel to the horizon is the wet moon, because in this position it would hold water. It is quite safe to say that it is just as possible to adopt one idea as the other—*since both are entirely wrong.* The moon has nothing to do with the weather, as far as any scientific data indicate.

The angle of the crescent moon with the horizon depends on one's latitude and the time of the year. In March and April, to the east of the sun the ecliptic extends considerably northward; thus, when the sun sets in the spring in mid-northern latitudes, the ecliptic is more nearly vertical to the horizon than at sunset at other seasons of the year. The evening crescent moon is also east of the sun, not far from the ecliptic, so the rays of the sun illuminating the moon strike it along that part nearest to the horizon — the resulting crescent appears parallel to the horizon. In the fall of the year just the opposite effect is observed; then the ecliptic makes a small angle with the horizon and the line from the sun to the moon is almost horizontal. The resulting evening crescent is seen nearly vertical.

But in the tropics, where the ecliptic always makes a nearly vertical angle with the horizon, sunlight on the crescent moon lights the lunar edge parallel to the horizon; while in the polar regions the crescent moon always seems to "stand" vertical. In the morning sky before sunrise, the vertical and horizontal crescents occur at just opposite times to those in the evening.

No relation has ever been found between the moon's phases and the weather, in spite of some individuals' claims to the contrary. The state of the atmosphere can influence the appearance of the moon, but not the other way around.

Among the more reliable weather proverbs is:

If the moon show a silver shield,
Be not afraid to reap your field;
But if she rises haloed round,
Soon we'll tread on deluged ground.

When there is a ring around the moon, rain often, but not always, follows. A lunar halo indicates the presence in the upper atmosphere of tiny particles of ice, forming cirrus, the highest of all clouds. These often move ahead of a storm area. The ice particles refract and break up the light of the moon, forming a halo of definite size, usually 22 degrees in radius.

Another fairly accurate weather proverb is:

Rainbow in the morning,
Sailors take warning;
Rainbow at night,
Sailor's delight.

A rainbow is formed when the light of the sun is broken up by raindrops into all the colors of which sunlight is composed. The rainbow always appears in the part of the heavens opposite the sun. A rainbow in the morning, therefore, must be in the western sky, indicating that there is rain to the west of the observer's position. Since our showers usually come from the west (often with the passage of a cold front), this rainbow to the west indicates a storm may soon be upon us. When the rainbow, on the other hand, is seen in the evening sky, it is to the east, and that

means that the rain has already passed the observer.

One sometimes hears the weather proverb that "when the sun draws water it will rain." Often, long radiating rays of sunlight emanate from a bank of clouds behind which the sun is concealed. These rays are illuminated particles of moisture in the air, indicating that the air is more humid than usual. But the sun is not "drawing" water up into the sky, at least no more than it ever does by heating the surface of the earth and causing evaporation of its moisture. Rain may follow or precede the appearance of these crepuscular rays, but it does not necessarily do so.

While an adequate understanding of the causes and forces underlying that very complex phenomenon known as weather requires long and serious study, the average person can enjoy applying trustworthy weather proverbs and some of the more obvious tricks of the amateur weather trade.

Few persons realize that they can tell the temperature of the air by observing such insects as ants and crickets. Dr. Harlow Shapley, of Harvard College Observatory, learned to estimate air temperature to within one degree Fahrenheit by the rapidity of the motions of ants. He found that the hotter it was the faster the ants ran about. If you are fond of the cheerful chirp of the cricket, and have forgotten to bring along a thermometer when out in the woods, just use the most convenient cricket. Count the number of chirps in 14 seconds; to that number add 40 and you have the temperature in degrees Fahrenheit. Authorities say that by this method you can obtain the correct temperature within one degree three times out of four, and nine times out of 10 you will be accurate within two degrees.

Sometimes we feel that we could well do with a little less weather, usually in the coldest parts of winter, or in the hottest stretches of summer. But a world without weather would to most human beings present an uninteresting and unstimulating environment. Often beautiful and sometimes awe-inspiring, weather is the vast backdrop against which our little lives are played.

What is it molds the life of man?
The weather.
What makes some black and others tan?
The weather.
What makes the Zulu live in trees,
And Congo natives dress in leaves,
While others go in furs and freeze?
The weather.

ASTRONOMICAL ANECDOTES

ARGELANDER AND THE BD

LAST month, when speaking of astronomically historical places that had been mentioned in the war news, I omitted the old university city of Bonn, where Argelander made the BD catalogue and charts. It fell to the Allies early in March.

Johann Gottfried Argelander took under his roof two refugees from the invasion of Napoleon and the defeat of the Prussian army at Jena in October, 1806. They were boys, one of them, then 10 years old, later to rule Prussia as Frederick William IV, the other his brother, aged nine, later the emperor of Germany, William I. For three years they were the companions of young Friedrich Wilhelm August Argelander. Later young Argelander became assistant and pupil to Bessel at Königsberg, but at the age of 24 he went to Finland, first to Abo, then, after that city burned, to Helsingfors, where he remained until 1836, when he went to Bonn. He remained there more than 38 years until his death at the age of 76; he was twice the chancellor of the university at Bonn.

Bessel had proposed a great star catalogue and atlas of objects as faint as magnitude 9, and Argelander put the proposal into execution between the years 1852 and 1863, with the assistance of several students.

Argelander has left us a description of how he made his catalogue. He worked at the eyepiece of the telescope, which had an aperture of less than three inches (focal length, 24 inches); the eyepiece was made by Kellner, and the combination yielded a wide field, with a magnifying power of 10 diameters. In the field of the eyepiece was a graduated piece of glass, of semicircular form, with the diameter vertical and marked so the differences in declination between the center of the field and the point where a star crossed the dark vertical line could be noted.

The telescope was equatorially mounted, but it was held fixed while this work was done. The instrument was clamped in declination and the stars drifted into the field. As a star crossed the center line—a portion of an hour circle—Argelander signaled on the floor to his assistant, in the room below, who would then note the instant of sidereal time. Argelander himself noted the difference in declination between the center of the field and the place where the star crossed, the magnitude of the star, whether it was double, or appeared nebulous. Later the records of Argelander and his assistant were combined, to yield the positions of the stars and the other pertinent information. In this way the material grew until at last the catalogue contained 324,188 stars in the northern heavens; the remarkably accurate charts drawn from the

Argelander lived from 1799 to 1875. This sketch was made by Leslie C. Peltier from an old portrait.

material of the catalogue are used often by astronomers even today.

The work was extended to southern declinations by Schönfeld, the successor of Argelander; the charts for this section are particularly fine. The *Cape Photographic Durchmusterung* continued from declination —20° to the south pole of the sky, and was published in 1896.

All variable star observers are familiar with Argelander's step method for estimating magnitudes. It seems obvious, yet it made it possible for relatively inexperienced observers to turn out accurate work in a field where the material has been too voluminous for the observational attention of professional astronomers. It seems a strange tragedy that many young Americans have had a chance to see Bonn—and, it is to be hoped, the observatory of Argelander—only because they must punish the countrymen of the patient astronomer who gave us the *Bonner Durchmusterung.* The news reports do not qualify the statement that "the University was destroyed."

R. K. M.

NEWS NOTES

By Dorrit Hoffleit

TRIPLE AND MULTIPLE STARS

Although data on multiple stars are still very incomplete, Dr. A. Wallenquist, at Upsala, Sweden, has made a preliminary survey of the apparent distribution and properties of such known systems brighter than magnitude 9. Classification is according to the relative proximity of the component stars. For instance, in triple systems *Dc* means a close double, *D*, with a distant companion, *c*; for example, Alpha Centauri and Proxima Centauri.

In other triple systems all the components are fairly close together; they are classed as *Cl*, meaning "cluster type." Similar classifications are applied to double binaries (Epsilon Lyrae), triple stars with one or more distant companions, and so forth.

By far the largest group are the *Dc* systems. In a total of 2,771 triple and multiple stars studied, 1,810 consist of a close pair with one distant companion, 378 are cluster-type triples, 448 are quadruple systems of all classes, and 135 are multiple systems of higher order.

The distribution of these various classes according to their apparent magnitudes, the magnitude differences of the component stars, their spectral classes, and the apparent positions in the sky, are investigated. From the charts shown by Dr. Wallenquist, it appears that there is very little galactic concentration among the *Dc* stars. The *Cl* triples are somewhat more concentrated toward the Milky Way and the higher-order systems a little more, but not nearly so much as typical open clusters, few of which have been found more than 30 degrees from the plane of the Milky Way. Indeed, it appears that a continuous relationship exists between the order of multiplicity of a stellar system and the percentage of all such systems close to the plane of the Milky Way.

PULSATING WHITE DWARFS

Pulsations in white dwarf stars which might last 1,000 years before dying out are proposed by Dr. P. L. Bhatnagar, of the University of Delhi. Most of the known pulsating stars are giants or supergiants (Cepheid and long-period variables), but the Indian scientist sees no reason why similar rhythmic expansions and contractions should not occur in denser stars, even in the white dwarfs.

"After a white dwarf has been created by the sudden collapse of a star," states Dr. Bhatnagar, "it is quite natural that the star should be left pulsating."

RED GIANT TO WHITE DWARF

According to Professor George Gamow, of George Washington University, a white dwarf may be the remains of a former red giant star, one in which the outer layers have been lost and the white dwarf core exposed. Dr. Gamow is the recipient of the award of the Washington Academy of Sciences for achievement in the physical sciences in 1944. The award was made "for distinguished service in theoretical physics, particularly in the understanding of atomic nuclei and of stars."

A normal main-sequence star, evolving in accordance with the carbon cycle of energy production, may eventually consume all of the hydrogen in its central region. Then the surrounding shell of gas must expand and the star will become a red giant. Surmounting difficulties encountered in his original paper, Dr. Gamow reports briefly in the *Physical Review*, February, 1945, on a revised stellar model he describes thus:

"The stable state of a star with a core exceeding ten per cent of the total mass will consist of three different regions: (1) degenerated nucleus, (2) isothermal layer of ideal gas, and (3) radiative envelope." The size and luminosity of the star are determined by conditions at the boundaries between the successive regions.

This stellar model leads to interesting and far-reaching conclusions. "It may be expected that with the gradual approach of the energy producing shell to the stellar surface, the star will begin to eject its outer layers .... The resulting loss of a large part of the stellar mass must lead finally to the unveiling of the white dwarf, which was gradually growing in the center of the star during the red giant part of its evolution."

Another inference, derived from a comparison with data on stars in spiral galaxies, is that stars in the arms of spirals are younger than the nuclei of such systems.

FIVE NEW WHITE DWARFS IN SOUTHERN SKIES

Harvard Announcement Card 699 reports the discovery of five new white dwarf stars on yellow and blue plates taken with the 60-inch reflector of the Cordoba Observatory, at Bosque Allegre, Argentina. The stars, found by W. J. Luyten and M. Dartayet, of the University of Minnesota, are at declinations south of —56°, and are fainter than photographic magnitude 14.5.

RE-OUTBURST OF NOVA (T) PYXIDIS

Word has just been received of the discovery by Dr. A. H. Joy, Mount Wilson Observatory, of another outburst of the old recurrent nova known as T Pyxidis. Dr. Joy reports that the star had increased in brightness by three magnitudes — normal minimum magnitude about 14.

Previous outbursts occurred in 1890, 1902, and 1920, when the star attained the 7th magnitude. This series of years gives an interesting sequence of intervals, namely 12, 18, and 25 years. If we can depend on this progression, the next maximum should occur 33 years from now, or in 1978.

A.A.V.S.O. observers have been diligently watching this nova, especially since 1930, but because of its faintness, its low altitude for northern observers, and the recent dearth of observers, not much success has been attained, even in seeing the star, except on rare occasions.

Few novae have been observed to undergo more than one outburst. RS Ophiuchi has presented two outbursts, one in 1898 and the other in 1933; U Scorpii underwent three outbursts, in 1863, 1906, and 1936. T Coronae Borealis, at maximum in 1866, is suspected of belonging to this class, judged by its behavior on that occasion. These recurrent novae may be the connecting link between the SS Cygni-type stars and regular novae.

LEON CAMPBELL
Harvard College Observatory

April 5, 1945

OCCULTATIONS—MAY, 1945

Local station, lat. 40° 48′.6 north, long. $4^h\ 55^m.8$ west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
May 7	6.4	290 B Aquarii	5:10.5 a.m.	41°	6:12.2 a.m.	274°
8	6.0	24 B Ceti	5:33.5 a.m.	53°	6:36.7 a.m.	256°
14	7.2	BD +22° 1364	9:12.8 p.m.	150°		
16	5.5	Eta Cancri	11:05.2 p.m.	87°	11:59.3 p.m.	306°
17	7.1	BD +18° 2182	10:38.0 p.m.	35°		
20	4.2	Nu Virginis	8:25.2 p.m.	90°	9:40.3 p.m.	337°
29	5.1	1 Sagittarii	0:00.4 a.m.	153°	0:52.3 a.m.	231°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

BOOKS AND THE SKY

SKY DIAGRAMS FOR 1945

U. S. Nautical Almanac Office, Supt. of Documents, Washington, D. C., 1944. 53 pages. 15 cents.

A GREAT many navigators, and especially all navigators who are not familiar with the planets, will welcome **Sky Diagrams.** As set forth in the explanation of the diagrams:

1. They are ready for immediate use without settings or tables of any kind.
2. Planets and the moon are shown as well as the stars.
3. True altitudes and bearings are shown on the diagrams without distortion.
4. The appearance of the sky for different latitudes and times is shown at one opening of the book, so the appearance for intermediate latitudes and times is easily visualized.

For each month, for six different latitudes (30° S to 70° N), at two-hour intervals during the night, a series of diagrams is provided, of which one example is reproduced here.

The cross at the center represents the zenith, the outside circle the horizon; azimuths are measured with north at the top and east at the right, as on navigation charts. The smallest circle is at altitude 60°, the other circle at 30°. An altitude scale enables the observer to measure the altitude of any celestial object represented.

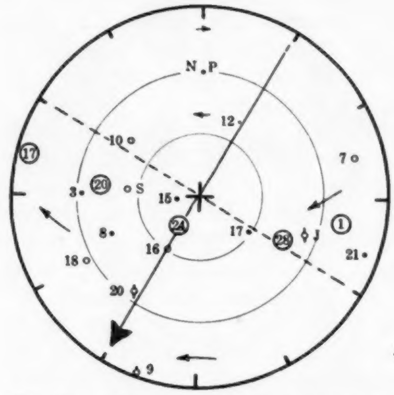
The stars shown are among the 22 navigational stars contained in **H. O. 218**; Rigel is 18, Betelgeuse is 8, Dubhe 12, Pollux 15, Spica 21, and so forth. The symbols represent magnitudes from —4 to +2 as in the **Air Almanac.** Jupiter and Saturn are indicated by the letters J and S, respectively.

The number inside the circle showing the moon's position gives the day of the month on which the moon has that place. The length of the small curved arrow indicates the hourly motion in that area of the sky. The positions of the stars and planets are given for the middle of the month, usually serving for the entire month. When Venus and Mars move considerably, positions for the first and last of the month are shown.

In this sample diagram, a heavy arrow indicates the true course of a craft on an imaginary flight: February 10, 1945, 2300 LCT, course 210°, in latitude

1945 FEBRUARY

23h



N30

30° N. The dotted line is perpendicular to the course, and a quick survey of the diagram shows that the best objects to give Sumner lines of position perpendicular and parallel to the course are 20 and 10, Sirius and Capella. The altitude scale places Sirius about 35° and Capella about 45° above the horizon.

Commodore J. F. Hellweg, superintendent of the U. S. Naval Observatory, states that 669 ships out of 689 have reported favorably as to the practical value of **Sky Diagrams,** and that aircraft replies are equally favorable. Commodore Hellweg and Dr. Wallace J. Eckert, former director of the U. S. Nautical Almanac, are to be congratulated on this excellent work. Presumably, **Sky Diagrams** will be published annually.

FRANCES W. WRIGHT
Harvard College Observatory

CONSIDER THE CALENDAR

Bhola D. Panth. Teachers College, Columbia University, 1944. 134 pages. $1.25.

THE purpose of this book is to present the historical perspective, pertinent facts, and the two salient alternative solutions relating to the problem of changing the calendar. Based on the thesis that in a democracy it is not only a privilege but the duty of each citizen to study matters relating to the general welfare and then to exercise his or her rights, Dr. Panth clearly and comprehensively outlines the story of the calendar in a simple and readable manner, so that the layman will have no trouble in weighing the facts and analyzing the situation, to the end that good judgment can be made.

That the calendar is no longer the private property of kings, dictators, priests, popes, and pontifices, to satisfy their whims and interest, is clearly set forth. **Consider the Calendar** is a very apt title, and one cannot read the book without realizing the true state of affairs—that the calendar is a vital instrument related to everyday life and it does not hinge on feast days, holy days, and so on. Dr. Panth points out that the calendar was conceived from the very beginning to serve human needs. Special days can be fitted to any kind of a calendar.

Consider the Calendar is the best treatment since Frothingham's erudite account in the British **Nautical Almanac** for 1935.

Of particular interest are the various analyses of our present calendar, and a resume of attempts at calendar improvement. The text holds your interest to the end, and it will be a wonder if you don't start trying to lay out a new calendar for yourself, only to give up and settle for the World calendar.

R. NEWTON MAYALL
American Association of
Scientific Workers

KEPLER AND THE JESUITS

M. W. Burke-Gaffney, Bruce Publishers, Milwaukee, 1944. 138 pages. $2.00.

KEPLER, the staunch protestant, had reasons to be friendly with the Jesuits who were active in the Counter-Reformation. Among them he found astronomers and mathematicians who were willing to exchange views, information, and publications with him. There are disagreements and arguments in the many letters cited; sometimes there is even a bit of outright snubbing, as in the case of Father Scheiner's observations of sunspots, but in general the reader will be pleasantly surprised by the cordiality and mutual understanding that characterize the relations between Kepler and his Jesuit contemporaries.

He also had reasons to be grateful to them. It was Father Guldin who somehow managed to find money for Kepler's empty pockets when his salary was slow in coming. It was Father Zucchi who made a telescope and presented it to him, and it was the Jesuits at Ingolstadt who took care of the printing of his ephemerides while he hastened to defend his mother against a charge of witchcraft.

The letters between Kepler and the many Jesuits who passed into and out of his life all belong to his brighter and happier moments. In general, the footsteps of this great man were dogged by misfortunes and private troubles. The reader will find in these selected letters some new views of Kepler the man.

The author has provided a bibliography and index, which makes the book a convenient source for historical reference. The letters have been translated into a style that is clear and easy to read.

FRANCIS J. HEYDEN, S.J.
Georgetown University

NEW BOOKS RECEIVED

THE ELEMENTS OF ASTRONOMY, *Edward Arthur Fath*, 1944, fourth edition, *McGraw-Hill*. 386 pages and charts. $3.00.

After a 10-year interval, a new edition brings this popular short textbook up-to-date. Many corrections and additions have been made, and some of the material, including the chapter on galaxies, has been completely rewritten.

GLEANINGS FOR A.T.M.s

MAKING YOUR OWN TELESCOPE

From Start to Finish—7

By ALLYN J. THOMPSON

VIII—THE TUBE AND ITS COLLIMATION; FINDER

The Mirror Cell. The wooden cell described here is easily made and permits of ready adjustment. The materials required are: two well-seasoned hardwood boards, one 6" square and ¾" thick, and the other about 8" square and 1" thick; three ¼-20 round-head stove bolts, 3" long, and nine washers to fit; three very stiff compression springs, ¼" to ½" long, and large enough to fit freely over the stove bolts; three ¼-20 wing nuts; three #10-24 round-head machine screws ⅝" long, and three #10-24, 1" long; clips for securing the mirror in the cell, which can be cut from brass angle shapes obtainable at the 5 & 10 cent store.

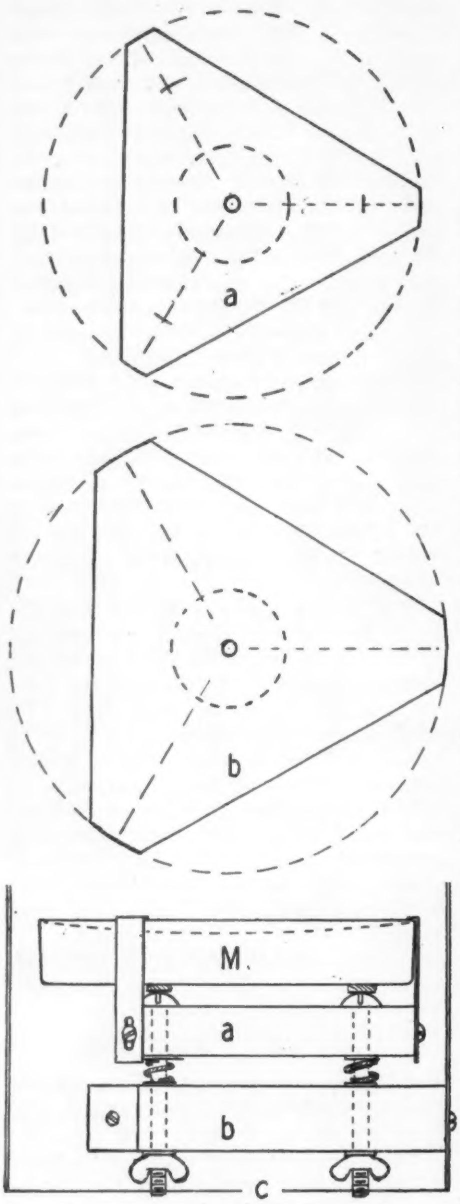


Fig. 25. Mirror cell parts, and assembled cell.

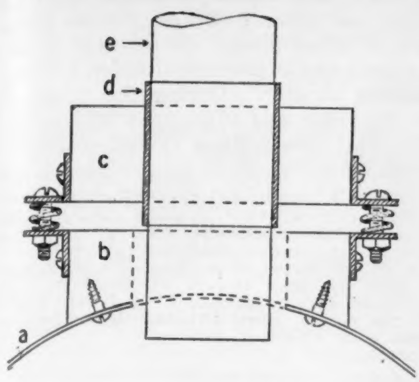
On the small board inscribe an equilateral "triangle" in a 6" circle as in Fig. 25a. Mark the holes for the stove bolts 2.1" from the center. On the large board lay off the equilateral "triangle" inscribed in a circle of the same diameter as the inside of the tube (Fig. 25b). Drill center holes in each, the size of a dowel stick or bit of rod that is on hand, and saw out the triangles. Center them on each other by passing the dowel stick or rod through the center holes, clamp them, and drill out the stove bolt holes with a ¼" drill. Before separating the triangles, mark them so that they can be returned to the same respective positions. Then enlarge the holes in triangle 25b with a 9/32" or 5/16" drill to permit free movement over the bolts. Drill holes in the angle clips with a #12 drill, and elongate them slightly with a small, round file. They are fastened to the corners of triangle 25a with the 5/8" #10 screws, first drilling holes for the screws into the wood with a #24 drill. The machine screws will have ample holding power and are preferred to wood screws where frequent removal may be necessary. Before placing the mirror in the assembled cell, file a small flat area on the heads of the stove bolts, and cement to them pieces of felt, cork, or leather for the mirror to rest on. The small dotted circles in the center of each triangle may be cut away with a keyhole saw to provide ventilation.

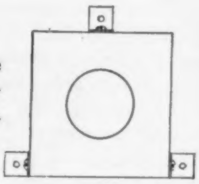
The cell is held in the tube by the three 1" #10 screws, entering triangle 25b through the sides of the tube, as in Fig. 25c. To bring the holes in the tube in the same plane, wrap a large sheet of paper around it with the paper's straight edge overlapping in that plane, and mark off the holes there, 120° apart.

Now blacken all parts of the cell with a flat black paint or enamel. The mirror must not be held tightly in the cell, as even slight flexure will distort its figure. It is therefore free to rotate, and sometimes does so from occasional jarring, throwing its axis out of alignment. To prevent this, a slight hole into which the point of a nail or screw may set is drilled into its back. For a drill, cut the head and point off a nail and put it in the drill press. Use #220 Carbo and water. It is best if this is done while the mirror is in the grinding stage; drill about 1/16" deep.

The Tube. This may be made of almost any material, sheet metal, cardboard, plywood, aluminum, or Bakelite tubing, or it may be of the skeleton

EDITED BY EARLE B. BROWN





Right: How angle brackets are attached to blocks.

Fig. 26. Adjustable saddle for eyepiece holder; a, telescope tube; b and c, wood blocks; d, brass bushing; e, telescoping adapter tube (1¼" inside diameter).

type. Rolled sheet metal is most frequently used. Aluminum (1/16" wall) and Bakelite (⅛" wall) are light and accurately round. The cardboard tube around which rugs are rolled is excellent if first doused inside and out with two or three coats of shellac. Any of these materials will provide all the strength and stiffness necessary for this telescope.

The tube's length should be about 52", the focal length of the mirror plus space to enclose the cell. To locate the eyepiece opening, measure 41½" from where the surface of the mirror will lie. At that point scribe a circle of ¾" radius. Drill numerous holes around this circle with a ⅛" drill and file out the hole, which, when smoothed up, should be 1⅝" in diameter.

CORRECTION

The formula for the width of the diagonal as given in the April issue should be: $D^1 = c(M-f)/F, +f$, instead of as given.

A block of hardwood, 3" square and 1" thick, should be taken to a pattern maker and shaped to fit the curve of the tube, and to have a 1⅝" hole bored squarely through its center. This block is fastened over the opening in the side of the tube.

At the same time have another block of wood of similar size bored out to receive a brass bushing having an outside diameter of 1 7/16". This bushing should be about 2" long, with a 1/16" wall, and must fit tightly into the block. It will be better if the wall is ⅛" thick, in which case the holes in the blocks must be larger. Use shellac to cement the bushing into place.

The eyepiece adapter tube, which telescopes snugly and smoothly into the bushing, is a piece of brass tubing about 4" long, 1¼" inside diameter, with a 1/32" wall. One end should have three or four longitudinal slots, about 1¼" long, cut into it with a hacksaw. The walls can then be sprung in slightly, insuring a firm grip on the eyepiece.

The two blocks are joined as in Fig. 26, with three compression springs between the matched angles to provide an adjustment that will bring the focal planes of mirror and eyepiece coincident.

If the telescope tube is accurately

BETTER POLISHING AGENTS

One of the industry's recent achievements has been the development of new and faster compounds for use in precision optics. Barnesite and cerium oxide are being more and more extensively used in finishing lenses, prisms, and mirrors. Neither has the staining property of rouge, and this will be gladsome news to the mirror maker.

Barnesite, so called after its producer, W. F. & John Barnes Co., is brown in color, and compounded of several of the rare earths. It is the finer and more expensive of the two, and is preferred for machine polishing, although a too-brief trial has not disclosed any superiority to cerium oxide in hand polishing, as with mirrors.

The *Encyclopaedia Britannica* tells us that cerium, a metallic element, the oxide of which was discovered in 1803, was named for the asteroid Ceres, which was also discovered about the same time. The oxide, CeO_2, a dull pink in color, is perhaps twice as fast as rouge. In the application of either product, the first few charges should consist of a rich, creamy mixture, tapering off to the addition of only clear water for figuring. The cost of these products at present is high. Cerium oxide is available in 8-ounce containers for $1.25 from Universal Shellac & Supply Co., 401 Broadway, New York 13, N. Y.

A.J.T.

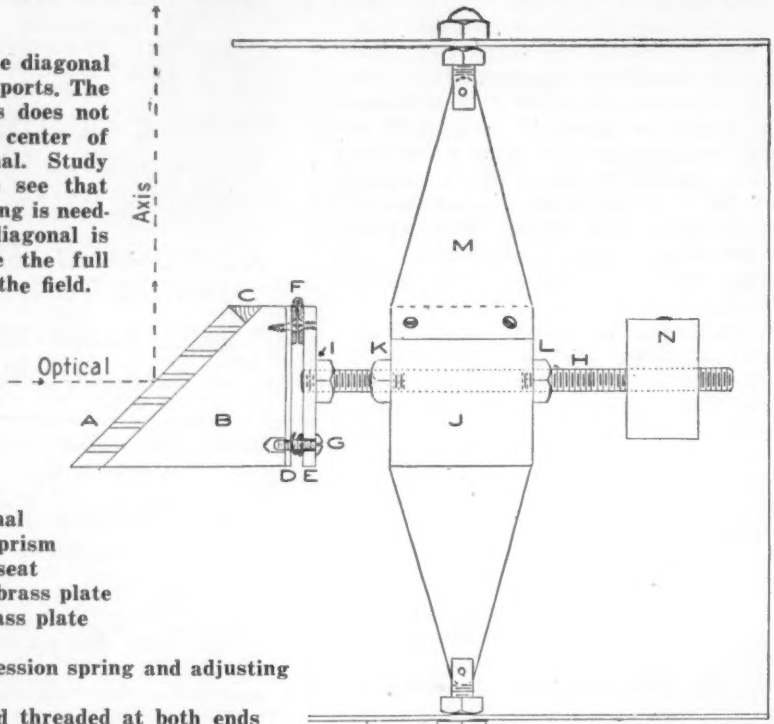
round, as, for example, a seamless aluminum tube, a single block of wood, 1¼" thick, may be used in place of the two blocks called for in Fig. 26. One side is milled to fit the curve of the tube, and if the center hole, of a size to accommodate the bushing, is bored radially to this curve, it will automatically square the adapter to the telescope tube.

Diagonal Holder. At this point a full-scale sectional drawing of the eyepiece end of the tube should be made, based on the findings of Fig. 21. Sketch in

away making a neat-fitting seat for the diagonal. The diagonal is held in place by three pieces of thin sheet metal (Fig. 28), one tacked to the back and one on each side of the wood prism. Use a hardwood stick in bending the "ears" of the metal strips over the corners of the diagonal. Do not pinch it tightly — there should be a barely perceptible shake to it.

A 1/16" brass plate is screwed to the base of the prism, and this is joined to the ⅛" brass plate of the holder by

Fig. 27. The diagonal and its supports. The optical axis does not strike the center of the diagonal. Study Fig. 21 to see that this offsetting is needed if the diagonal is to embrace the full width of the field.



A. Diagonal
B. Wood prism
C. Wood seat
D. 1/16" brass plate
E. ⅛" brass plate
F. Hinge
G. Compression spring and adjusting screw
H. ¼" rod threaded at both ends
I. Lock nut or soldered joint
J. Spider support (Fig. 29)
K and L. Lock nuts
M. Vanes N. Counterpoise

means of a small hinge. A #6-32 screw, and a compression spring between the plates, opposite the hinge, provide adjustment in the angle of deflection. The ⅛" plate screws onto a length of ¼-20 rod, about 1/16" **offset from center,** as can be seen from Fig. 27, and is made tight against the lock nut, which joint should be soldered. The rod,

the detail of the eyepiece holder, diagonal, supports, spider attachment and so forth, as in Fig. 27. Note that one of the short edges of the diagonal is ground back at an angle of 45°, thus

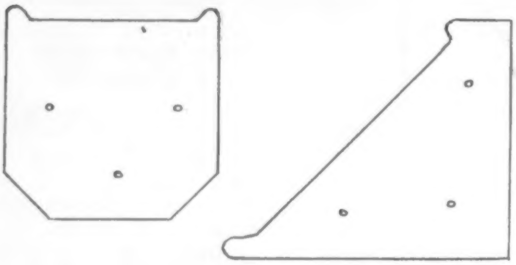


Fig. 28. Thin sheet-metal pieces which secure diagonal A to wood prism B in Fig. 27. Use a hardwood stick to bend the ears of these strips over the corners of the diagonal—not too tightly.

reducing the obstruction, and effecting a neat fit on the support. Use #80 for this edging, and protect the face of the diagonal with adhesive tape. The block on which the diagonal rests is a prism-shaped piece of hardwood 1.7" on the square sides. A ⅜" or ½" square-sectioned strip of wood is glued across the base of the hypotenuse face of the prism, and later one half of it is planed

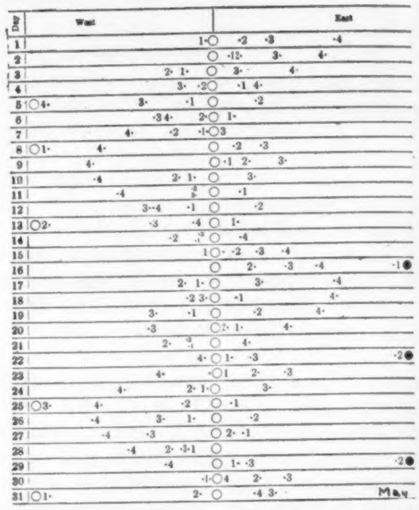
threaded at both ends, is held in the spider support, and is provided with a small longitudinal adjustment to compensate for error in locating the holes for the spider in the tube. A small counterweight may be used to remove torque from the vanes.

(To be continued. Next month the spider support, saddle, collimation, and the finder will be described.)

JUPITER'S SATELLITES

During the evenings of May 1st and 14th, and after 2:08 a.m. on the 16th, the principal moons will be east of the primary and in numerical order, I being nearest Jupiter. During the evenings of May 6th and 27th, they will be on the west side. Moon IV will reappear from eclipse at 10:46 p.m. on May 13th.

Jupiter's four bright moons have the positions shown below at 12:30 a.m., E.W.T. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the American Ephemeris and Nautical Almanac.



OBSERVER'S PAGE

By Jesse A. Fitzpatrick

All times mentioned on the Observer's Page are Eastern war time.

A Fine Meteor Photograph

TEXAS OBSERVERS' BULLETIN for March included a photograph of a Perseid meteor which shows what amateur photographers can do in this branch of astronomical observation, requiring only moderate equipment and plenty of patience. The photograph is reproduced on the front cover and the following material is in part taken from that issue of the **Bulletin** and in part supplied by its editor, Oscar E. Monnig, of Ft. Worth.

During the Perseids of 1944, James H. Logan, of Dallas, exposed a number of Super XX films with his Leica camera at f/2. On the seventh exposure, nine minutes long, taken on the morning of August 12th, a meteor trail appears. Mr. and Mrs. Logan were observing each night when these films were being exposed, and five bright meteors were plotted each night. The original visual record of this meteor lists it as a Perseid of magnitude —1, color white, duration of flight 0.3 second, duration of train 0.6 second, with plotted path from 194548 to 185619 (co-ordinates a la A.A.V.S.O.), accuracy fair. It was noted at the time that this meteor "went smack-dab through the camera field." The course paralleled the Milky Way, a characteristic of the Perseids in constellations lying near that celestial band, since the radiant is in its edge.

Lyra is easily identified at the top of the photo—Vega is the broad, bright band with Epsilon showing double nearby. Delta Lyrae also appears double, while the meteor itself cuts the trail of Gamma Lyrae practically in half. The meteor, as photographed, apparently started near Theta Lyrae, where the trail is thinnest; this puts the thicker, final portion (a mild terminal flare) near the end, as one would expect of a typical Perseid. The path is about 15 degrees long, ending midway between 109 and 110 Herculis. The trail at first appears to be flickering, but close examination reveals that the apparent spindles are an effect of the intersections of the meteor trail and star trails—the latter so faint in some cases as to be almost invisible.

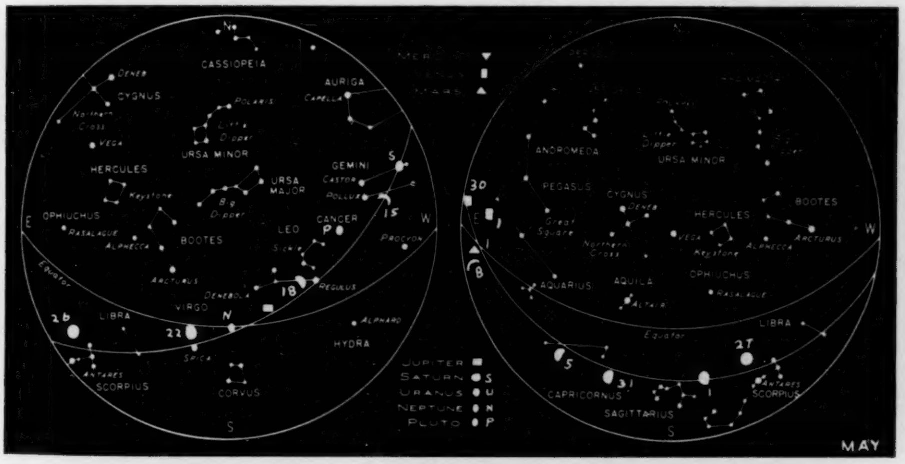
It is natural to estimate the meteor's probable magnitude by comparison with the star trails, on the theory that if the product of the light intensity and exposure time is the same, the resulting trails will be of the same density. Although this may not hold precisely for the limits considered here, the trail seems to resemble 4th-magnitude stars pretty closely, with the brightest part perhaps half a magnitude brighter and the faintest over two magnitudes fainter. This is rough, without taking color into account; the panchromatic film, however, seems to have recorded red stars as bright as blue ones of the same magnitude.

Comparison of the speed of the meteor with that of the stars at declination +30° indicates a factor of about 2,780 in length of exposure, corresponding roughly to about seven magnitudes. In other words, the meteor's photographic brightness was about seven magnitudes greater than that of the 4th-magnitude stars it resembles. This would make it magnitude —3. Mr. Logan estimated the apparent speed as even greater than 10 degrees per second, which was the basis of this calculation, and he thought the meteor to be only magnitude —1. Obviously, a substantial part of the difference must be attributed to the brightness of the train lasting 0.6 second; it might account for one or two magnitudes of the apparent brightness of the recorded path.

A plot of corresponding points of the brighter trails enables one to make a quick star chart for comparison with an atlas of the stars in the region.

The films were developed in DK 20; focal length of the lens is 50 mm.; it is a Summar lens of 48° field, only part of the original picture being reproduced here. A total of 14 exposures was made from 10:15 p.m. August 11th through 2:52 a.m. August 13th, total time 233 minutes. The reproduction is from an enlargement furnished by the photographer. Note that the opening and the closing of the shutter shook the camera enough to give a separate star image at each end of the bright star trails.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 4:30 a.m. on the 7th of the month, and at 3:30 a.m. on the 23rd. At the left is the sky for 10:30 p.m. on the 7th and for 9:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury will be at greatest elongation west, 26° 13′, on May 11th. This will not be favorable for observers in mid-northern latitudes. The planet is in the morning sky, rising nearly an hour before the sun throughout the month.

Venus, in the morning sky in Pisces, will be at the phase of greatest brilliancy on May 21st, at magnitude —4.2.

Mars, also in Pisces, will reach magnitude +1.2 at the end of May. It will draw closer to Venus through the month.

Jupiter is in Leo, near the meridian at sunset. It will resume progressive motion on May 15th.

Saturn is in Gemini, setting in the evening sky.

Uranus is too near the sun for observation.

Neptune is in Virgo. See diagram in the January issue.

OCCULTATION OF SATURN

The occultation of Saturn by the moon on May 14th can be observed only in the extreme West and the southwestern corner of the United States. At the standard station in California, long. +120° and lat. +36°, which is about midway between Los Angeles and San Francisco, the immersion at 8:21.1 P.W.T. will follow sunset by less than half an hour.

PHASES OF THE MOON

Last quarter	May 5, 2:02 a.m.
New moon	May 11, 4:21 p.m.
First quarter	May 18, 6:12 p.m.
Full moon	May 26, 9:49 p.m.

MAY OCCULTATIONS
Table on page 15.

Here and There with Amateurs

This is not intended as a complete list of societies, but rather to serve as a guide for persons near these centers, and to provide information for transplanted amateurs who may wish to visit other groups. The asterisks denote societies whose members receive *Sky and Telescope* as a privilege of membership.

City	Organization	Date	P.M.	Season	Meeting Place	Communicate with
BOSTON	*Bond Ast. Club	1st Thu.	8:15	Oct.-June	Harvard Obs.	Miriam Bond, Harvard Observatory
"	*A.T.M.s of Boston	2nd Thu.	8:15	Sept.-June	Harvard Obs.	F. A. Pflug, 685 Centre St., Jamaica Plain
BROOKLYN, N. Y.	Astr. Dept., B'klyn Inst.	Rd. Table 3rd Thu.	8:15	Oct.-April	Brooklyn Inst.	William Henry, 154 Nassau St., N. Y. C., *BA*. 7-9473
BUFFALO	A.T.M.s & Observers	1st, 3rd Fri.	8:00	Oct.-June	Mus. of Science	J. J. Davis, Museum of Science
CHATTANOOGA	Barnard A. S.	4th Fri.	7:30	All year	Chattanooga Obs.	C. T. Jones, 326 James Bldg., *CHat*. 7-1936
CHICAGO	*Burnham A. S.	2nd Tue.	8:00	Sept.-June	Chi. Acad. of Sciences	Miss W. Sawtell, 928 N. Harvey, Oak Park
CINCINNATI	*Cin. A.A.	2nd Fri.	8:00	Sept.-June	Cincinnati Obs.	Dan McCarthy, 1622 DeSales Lane
CLEVELAND	Cleveland A. S.	Fri.	8:00	Sept.-June	Warner & Swasey Obs.	Mrs. Royce Parkin, The Cleveland Club
DAYTONA BEACH	D. B. Stargazers	Alt. Mon.	8:00	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	*Detroit A. S.	2nd Sun.	3:00	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	*Northwest A. S.	3rd Tue.	8:00	Sept.-June	Redford High Sch.	E. P. Holleran, 12305 Turner Ave.
DULUTH, MINN.	Duluth Ast. Club	Meetings suspended				Ray S. Huey, 1822 E. 3rd St.
FT. WORTH	Tex. Observers	No regular meetings				Oscar E. Monnig, 1010 Morningside Dr.
GADSDEN, ALA.	Ala. A.A.	1st Thu.	7:30	All year	Ala. Power Audit.	Brent L. Harrell, 1176 *W* or 55
INDIANAPOLIS	Indiana A.A.	1st Sun.	2:15	All year	Odeon Hall	E. W. Johnson, 808 Peoples Bank Bldg.
JOLIET, ILL.	Joliet A.S.	Alt. Tue.	8:00	Oct.-May	Jol. Mus. & Art Gall'y	Mrs. Robert L. Price, 403 Second Ave.
LOS ANGELES	L.A.A.S.	2nd Thu.	8:15	———	2606 W. 8th St.	A. M. Newton, 2606 W. 8th St.
LOUISVILLE, KY.	L'ville A.S.	3rd Tue.	8:00	Sept.-May†	University Center, Univ. of Louisville	Mary Eberhard, 3-102 Crescent Ct. *Taylor* 4157
MADISON, WIS.	Madison A.S.	2nd Wed.	8:00	All year	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
MEMPHIS	A.T.M.s of Mem.	Alt. Tue.	7:30	All year	Private houses	James Woody, 1056 Linden Ave.
MIAMI, FLA.	Southern Cross A.S.	Every Fri.	7:30	All year	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26th Road
MILWAUKEE	Milw. A.S.	1st Thu.	6:15	Oct.-May††	City Club	E. A. Halbach, 2971 S. 52 St.
MOLINE, ILL.	*Pop. Ast. Club	Wed.†††	7:30	Feb.-Nov.	Sky Ridge Obs.	Carl H. Gamble, Route 1
NEW HAVEN	New Haven A.A.S.	4th Sat.	8:00	Sept.-June	Yale Obs.	J. J. Neale, 29 Fairmont Ave.
NEW ORLEANS	A.S. of N. Orleans	Last Wed.	8:00	Sept.-May	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
NEW YORK	*A.A.A.	1st, 3rd Wed.	8:15	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN*. 2-8500
"	Junior Ast. Club	1st, 3rd Fri.	8:00	Oct.-May	Amer. Mus. Nat. Hist.	J. B. Rothschild, Hayden Plan., *EN*. 2-8500
NORFOLK, VA.	A.A.S. of Norfolk	2nd Thu.	8:00	All year	635 W. 29th St.	P. N. Anderson, 635 W. 29th St.
NORWALK, CAL.	Excelsior Tel. Club	Thu.	7:00	All year	Excelsior Union H. S.	Geo. F. Joyner, 410 Sproul St.
NORWALK, CONN.	Norwalk Ast. Soc.	Last Fri.	8:00	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
OAKLAND, CAL.	Eastbay A.A.	1st Sat.	8:00	Sept.-June	Chabot Obs.	Miss H. E. Neall, 6557 Whitney St.
OWENSBORO, KY.	*Owensboro A. C.	3rd Sat.	8:00	All year	Public Library	Fred Rutley, 129 W. 19th St.
PHILADELPHIA	A.A. of F.I.	3rd Fri.	8:00	All year	The Franklin Inst.	Edwin F. Bailey, *Rit*. 3050
"	*Rittenhouse A.S.	2nd Fri.	8:00	Oct.-May	The Franklin Inst.	A. C. Schock, *Rit*. 3050
PITTSBURGH	*A.A.A. of P'burgh	2nd Fri.	8:00	Sept.-June	Buhl Planetarium	Louis E. Bier, 837 Estella St.
PONTIAC, MICH.	*Pontiac A.A.A.	2nd Thu.	8:00	All year	Private homes	Harvey E. Orser, 34 Pine St.
PORTLAND, ME.	A.S. of Maine	2nd Fri.	8:00	All year	Private homes	H. M. Harris, 27 Victory Ave., S. Portland
PORTLAND, ORE.	*Ast. Study Group	1st Wed.	8:00	All year	No. 9 Pacific Bldg.	H. J. Carruthers, 427 S. E. 61 Ave.
PROVIDENCE, R.I.	Skyscrapers, Inc.	Mon. or Wed.	8:00	All year	Ladd Observatory	Ladd Obs., Brown U., *GA*. 1633
RENO, NEV.	A.S. of Nev.	4th Wed.	8:00	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	Roch. Ast. Club	Alt. Fri.	8:00	Oct.-May	Univ. of Rochester	M. L. Groff, 400 University Ave.
SAN DIEGO, CAL.	Ast. Soc. of S. D.	1st Fri.	7:30	Oct.-June	504 Elec. Bldg.	R. M. Lippert, Box 41, N. Park Sta.
SCHENECTADY	S'tady Ast. Club	Meetings suspended				C. H. Chapman, 216 Glen Ave., Scotia
SOUTH BEND, IND.	St. Joseph Val. Ast.	Last Tue.	8:00	All year	928 Oak St.	F. K. Czyzewski, South Bend Tribune
TACOMA, WASH.	Tacoma A.A.	Meetings suspended				Grant Burke, Route 3, Box 349
TULSA, OKLA.	Tulsa A.S.	Occasional meetings				V. L. Jones, 4-8462
WASHINGTON, D.C.	Nat'l. Cap. A.A.A.	1st Sat.	8:00	Oct.-June	U. S. Nat'l. Museum	Miss D. Harris, 1621 T St., N.W., *Du*. 4200
WICHITA, KANS.	*Wichita A.S.	2nd Tue.	8:00	All year	E. High Sch., Rm. 214	S. S. Whitehead, 2322 E. Douglas, 33148
WORCESTER, Mass.	*Aldrich Ast. Club	2nd Tue.	7:30	All year	Mus. Natural History	W. C. Lovell, 158 Austin, 31559
YAKIMA, WASH.	Yak. Am. Astr'mers	3rd Tue.	7:30	All year	Chamb. of Comm. Bldg.	C. A. Zumwalt, 1019 Pleasant

†June, Jul., Aug., City parks ††Dinner meeting †††Nearest 1st-quarter moon

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Planetarium Notes

Sky and Telescope is official bulletin of the Hayden Planetarium, 81st Street and Central Park West, New York City, and of the Buhl Planetarium, Federal and West Ohio Streets, Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents in *May*, PLANET NEIGHBORS OF THE EARTH.

Eight major planets besides the earth are known today. In this production we examine each, from Mercury out to Pluto, most distant world yet discovered. We see the variety of their physical conditions and discuss the possibility of life upon them, a question on which recent discoveries throw new light. We also wonder whether or not there are other such systems of planets in space.

★ **THE HAYDEN PLANETARIUM** presents in *May*, WHY THE WEATHER? (See page 12.)

In *June*, THE SUN AND ECLIPSES. Our sun supports life on the earth, but will it go on doing so forever? How can the relatively tiny moon blot out its light so completely during an eclipse, such as the coming event of July 9th? The causes of eclipses are explained in this demonstration, and on clear days the sun's big image is brought right inside the planetarium dome.

★ SCHEDULE BUHL PLANETARIUM

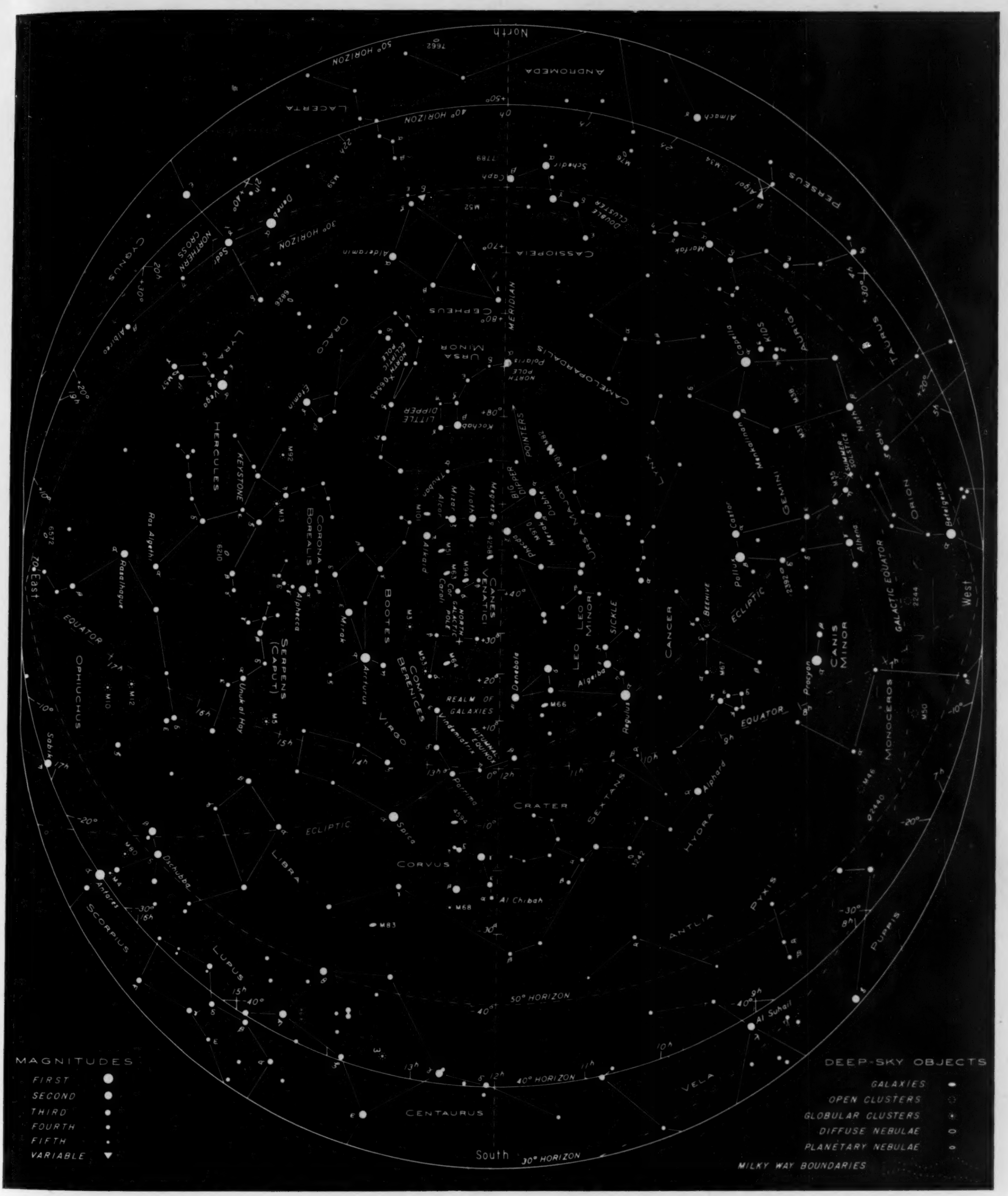
Mondays through Saturdays .... 3 and 8:30 p.m.
Sundays and Holidays .... 3, 4, and 8:30 p.m.

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, John F. Landis; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr.; *Instructor, School of Navigation*, Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays .... 2, 3:30, and 8:30 p.m.
Saturdays .... 11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays .... 2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles (on leave in Army Air Corps); *Scientific Assistant*, Fred Raiser; *Lecturers*, Charles O. Roth, Jr., Shirley I. Gale, John Saunders.



DEEP-SKY WONDERS

AMONG marvels for observation in the May skies are the objects listed here, some of which are not shown on the chart above. The informal descriptions are for common telescopes.

Virgo. M61, 12h 19m.4, +4° 45′; galaxy. Large, round, dim, with starlike center. May is the ideal month for galaxies, as Leo, Coma, and Virgo are on or near the meridian. M49, 12h 27m.3, +8° 16′; galaxy. Dim, small, elliptical.

Ursa Major. M82, 9h 51m.9, +69° 56′; irregular galaxy, edge-on, with billowy outline. See back cover of **Sky and Telescope**, March, 1945. Especially good for amateur observation; can be seen in a 3-inch telescope. In the same large field with M81, less conspicuous oval galaxy.

Coma Berenices. M99, 12h 16m.3, +14° 42′; galaxy. Round with bright center. NGC 5053, 13h 13m.7, +17° 59′; globular, small and dim. L. S. COPELAND

STARS FOR MAY

from latitudes 30° to 50° north, at 10 p.m. and 9 p.m., war time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.